INSTRUCTION AND OPERATING MANUAL

FOR

MODEL LM-18 FREQUENCY METER

(ALSO APPLICABLE TO MODELS LM-10, LM-11,
LM-12, LM-13, LM-14, LM-15, LM-16, LM-17
and LM-19)

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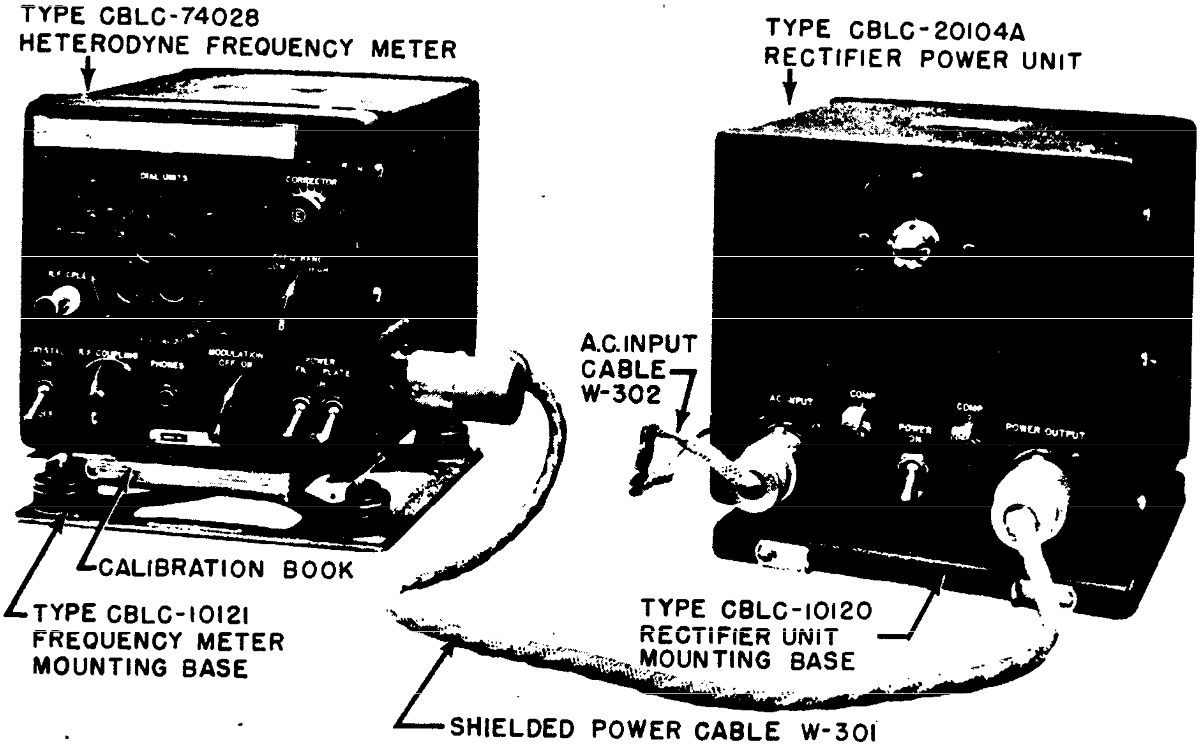

TYPE CBLC-74028
HETERODYNE FREQUENCY METER
TYPE CBLC-20104A
RECTIFIER POWER UNIT
A.C. INPUT CABLE W-302
CALIBRATION BOOK
TYPE CBLC-10121 FREQUENCY METER MOUNTING BASE
TYPE CBLC-10120 RECTIFIER UNIT MOUNTING BASE
SHIELDED POWER CABLE W-301

Figure 1–1. Model LM–18 Crystal Calibrated Frequency Indicating Equipment — System Components

GENERAL DESCRIPTION

1. PURPOSE OF HANDBOOK.

This handbook contains instructions for the installation, operation, maintenance, and servicing of the Model LM–18 Crystal Calibrated Frequency Indicating Equipment.

2. PURPOSE OF EQUIPMENT.

The Model LM–18 Crystal Calibrated Frequency Indicating Equipment is specially designed to provide a simple, accurate, and reliable frequency indicating equipment of the crystal calibrated type for use in the Naval radio service. It is adaptable for adjusting radio transmitters and receivers to any desired frequency in the range from 125 to 20,000 kcs. The equipment provides accuracies of 0.02 percent in the 125-to-2000-kcs. band, and 0.01 percent in the 2000-to-20,000-kcs. band, at any temperature in the range from minus 32 to plus 65 degrees Centigrade.

3. EQUIPMENT SUPPLIED.

The major units and components supplied with each Model LM–18 Crystal Calibrated Frequency Indicating Equipment are shown in figure 1–1 and listed in table 1–1.

TABLE 1–1. EQUIPMENT SUPPLIED

QUANTITY PER EQUIPMENT	NAME OF UNIT	NAVY TYPE DESIG.	OVER-ALL DIMENSIONS (MAX.)			VOL.	WT.
			HEIGHT	WIDTH	DEPTH		
1	Heterodyne Frequency Meter	CBLC–74028	8½	7 15/16	8⅝	0.236	11.38
1	Frequency Meter Mounting Base	CBLC–10121	1⅝	7⅞	7	....	0.38
1	Rectifier Power Unit	CBLC–20104A	8 3/16	8 3/16	8 15/16	0.297	13.0
1	Rectifier Unit Mounting Base	CBLC–10120	⅝	7¾	7¾	....	0.44
1	Shielded Power Cable	W–401	108	½	....	....	2.19
1	A.C. Input Cable	W–402	120	½	....	....	2.06
1	Calibration Book	......	⅜	5½	8	....	0.25
2	Instruction Book	......	¼	8½	11	....	....

Unless otherwise stated, dimensions are in inches, volume in cubic feet, weight in pounds.

4. EQUIPMENT REQUIRED BUT NOT SUPPLIED.

The Model LM–18 Crystal Calibrated Frequency Indicating Equipment is complete when the companion units, Type CBLC–74028 Heterodyne Frequency Meter and Type CBLC–20104A Rectifier Power Unit, are connected together.

For standard installations, the following equipment is required but not supplied.

TABLE 1–2. EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED

QUANTITY PER EQUIPMENT	NAME OF UNIT	NAVY TYPE DESIG.	REQUIRED USE	REQUIRED CHARACTERISTICS
1	Headset	....	Calibratinn and monitoring	600 ohm impedance
1	Power Source	....	Power source for Rectifier Unit	100-130 volts, 50-60 cycles, a.c.

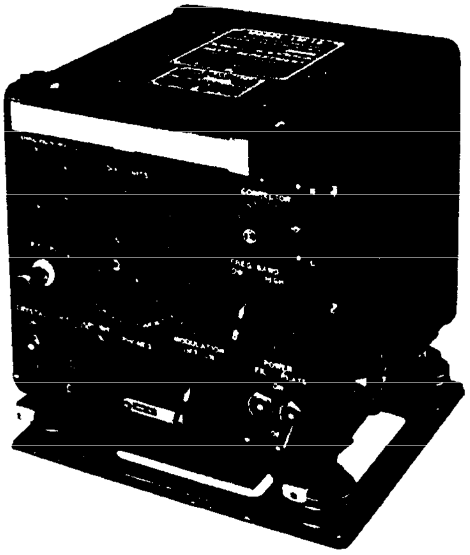


Figure 1–2. Heterodyne Frequency Meter—Front View

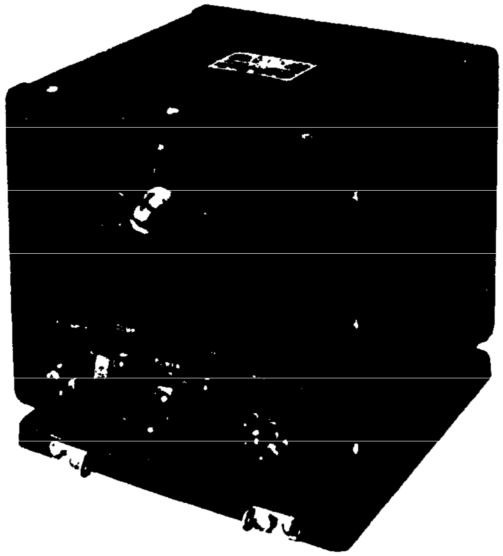


Figure 1–3. Rectifier Power Unit — Front View

5. SHIPPING DATA.

The Model LM–18 Crystal Calibrated Frequency Indicating Equipment is shipped complete with all tubes in place. The weight, volume, and dimensions of the Model LM–18 Equipment, as packed for shipment, are indicated in table 1–3.

TABLE 1–3. SHIPPING DATA

	CONTENTS	OVER-ALL DIMENSIONS (MAX.)			VOL-UME	WEIGHT
DESIGNATION	NAME	HEIGHT	WIDTH	DEPTH		
Master carton		13	12½	24	2.28	39
Frequency Meter carton	1–Type CBLC–74028 Heterodyne Frequency Meter	10½	9¾	19½	1.10	14
Power Unit carton	1–Type CBLC–20104A Rectifier Power Unit	10½	10	19½	1.18	15
Cable carton	1–Power Cable 1–Input Cable	10½	2¼	9	0.12	3

Dimensions are in inches, volume in cubic feet, weight in pounds.

6. MODEL LM EQUIPMENT SIMILARITIES.

All Frequency Meter units of the Model LM Equipment series are completely interchangeable electrically and mechanically, with the exception of the Model LM and LM–1 Equipments, which are not designed for operation with 260/475-volt plate supplies. Table 1–4 indicates the similarity between various revisions of the Model LM Equipment series. This handbook is applicable to all equipments subsequent to and including the Model LM–10 Equipment.

TABLE 1–4. BASIC SIMILARITIES IN MODEL LM EQUIPMENTS

MODEL	FREQUENCY MEASURING UNIT TYPE	HET. OSC. FREQ. RANGE KCS.	OPERATING VOLTAGE	MECHANICAL DESIGN	REMARKS
LM	None	195–400 2000–4000	12/14 200/260		
LM–1	None	195–400 2000–4000	External battery supply	Same as LM.	Voltage regulator circuit added.
LM–2	None	195–400 2000–4000	12/14 200/260 260/475	General minor improvements throughout.	
LM–3	None	195–400 2000–4000	External battery supply	Same as LM–2.	
LM–4	None	195–400 2000–4000	12/14 200/260 260/475	Same as LM–2.	Symbol designations reassigned.

TABLE 1–4. (CONTINUED)

MODEL	FREQUENCY MEASURING UNIT TYPE	HET. OSC. FREQ. RANGE KCS.	OPERATING VOLTAGE	MECHANICAL DESIGN	REMARKS
LM-4a	None	195–400 2000–4000	24/28 200/260 260/475	Same as LM-4.	
LM-5	None	195–400 2000–4000	12/14 200/260 260/475	Same as LM-4.	
LM-6	CRR-74023	195–400 2000–4000	Rectifier Power Unit Type CRR-20104	Same as LM-4.	
LM-7	CRR-74024	195–400 2000–4000	12/14–24/28 200/260 260/475	Redesigned shockmount base, and capacitor and drive assembly.	
LM-8	CRR-74024	195–400 2000–4000	Rectifier Power Unit Type CRR-20104	Same as LM-7.	
LM-9	CRR-74024	195–400 2000–4000	12/14–24/28 200/260 260/475	Same as LM-7.	Included in Type CRR-10086 Waterproof Carrying Case.
LM-10	CRR-74028	125–250 2000–4000	12/14–24/28 200/260 260/475	Minor mechanical revisions.	LF het. osc. fundamental frequency range changed.
LM-11	CRR-74028	125–250 2000–4000	Rectifier Power Unit Type CRR-20104 or Rectifier Power Unit Type CRR-20104A	Same as LM-10.	
LM-12	CRR-74028	125–250 2000–4000	12/14–24/28 200/260–260/475	Same as LM-10.	Included in Type CRR-10086 Waterproof Carrying Case.
LM-13	CRR-74028	125–250 2000–4000	Self-contained batteries	Same as LM-10, less shockmount base.	Mounted in Type CRR-10111 Carrying Case with batteries.
LM-14	CKB-74028	125–250 2000–4000	12/14–24/28 200/260–260/475	Same as LM-10.	
LM-14	CBLC-74028	125–250 2000–4000	12/14–24/28 200/260–260/475	Same as LM-10.	
LM-15	CKB-74028	125–250 2000–4000	Rectifier Power Unit Type CKB-20104 or CKB-20104A	Same as LM-10.	
LM-16	CKB-74028	125–250 2000–4000	12/14–24/28 200/260–260/475	Same as LM-10.	Included in Type CRR-10086 Waterproof Carry-Case.
LM-17	CKB-74028	125–250 2000–4000	Self-contained batteries	Same as LM-10.	Mounted in Type CKB-10111 Carrying Case and CKB-10110 Canvas Bag, complete with batteries.
LM-18	CRR-74028	125–250 2000–4000	Rectifier Power Unit Type CRR-20104A	Same as LM-10.	
LM-18	CBLC-74028	125–250 2000–4000	Rectifier Power Unit Type CBLC-20104A	Same as LM-10.	
LM-19	CRR-74028	125–250 2000–4000	12/14–24/28 200/260–260/475	Same as LM-10.	Included in Type CRR-10086 Waterproof Carry-Case.

NOTE

All rectifier power units listed in table 1–4 operate with a source of 100 to 130 volts, 50 to 60 cycles a.c.

7. ELECTRICAL CHARACTERISTICS.

The electrical characteristics of the Model LM-18 Crystal Calibrated Frequency Indicating Equipment are tabulated in table 1-5.

TABLE 1-5. ELECTRICAL CHARACTERISTICS OF THE MODEL LM-18 EQUIPMENT

CHARACTERISTIC	DESCRIPTION	REMARKS
a. Type CBLC-74028 Heterodyne Frequency Meter:		
Frequency Range	125 to 20,000 kcs.	Covered in two bands: 125-2000 kcs.; 2000-20,000 kcs.
Frequency Control	1000 kc. crystal	AT-cut crystal; accuracy ± 10 cycles at 20° C.
Calibration Accuracy	0.02% for 125-2000 kcs. 0.01% for 2000-20,000 kcs.	Accuracy maintained from minus 32° C. to plus 60° C.
Output Voltage	250 microvolts. minimum	Specified output over entire frequency range; both bands.
Modulation	500 cycles, 40%	AM modulation.
Power Requirements	12.6 volts a.c. at 0.6 amp.; 260-475 volts d.c. at 17 to 20 ma.	Supplied by Rectifier Power Unit Type CBLC-20104A.
b. Type CBLC-20104A Rectifier Power Unit:		
Line Voltage	100-130 volts, 50-60 cycles, a.c.	Compensation for low and high line voltages provided.
Power Consumption	28.0 watts at 115 volts, 60 cycles a.c.	
Current Drain	0.28 amps, at 115 volts, 60 cycles a.c.	
Power Factor	86 percent	
Output Voltages	12.6 volts a.c. at 0.6 amps. 320 volts d.c. at 20 ma.	Measured under load.

8. DESCRIPTION OF MAJOR UNITS.

a. GENERAL.—The Model LM-18 Crystal Calibrated Frequency Indicating Equipment consists of the Type CBLC-74028 Heterodyne Frequency Meter and the Type CBLC-20104A Rectifier Power Unit, together with the required mounting bases, connecting cables, and calibration book.

The Frequency Meter contains a fixed-frequency, crystal-controlled oscillator used as a reference standard, and a tunable heterodyne oscillator. The equipment includes a 500-cycle modulator which may also be operated as an audio amplifier, and a high-gain detector. The Frequency Meter provides an accurate, calibrated source of radio-frequency energy in the range from 125 to 20,000 kcs., for use with transmitting and receiving equipments. The unit may be used as a frequency meter or test oscillator, with AM-modulation of the output signal when required.

The Rectifier Power Unit supplies the Frequency Meter with the necessary filament and plate voltages. The unit operates on 50 to 60 cycles, single phase a.c.,

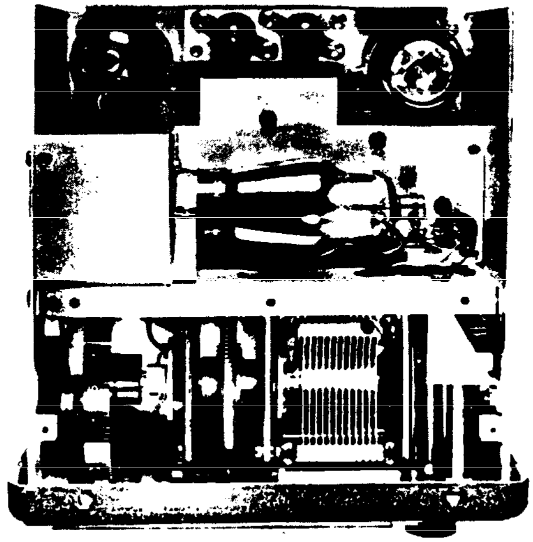


Figure 1-4. Heterodyne Frequency Meter — Top View, Case Removed

from 100 to 130 volts. The wide range of allowable input voltages is compensated for by means of taps on the primary of the power transformer.

b. TYPE CBLC-74028 HETERODYNE FREQUENCY METER. (*See figures 1-2, 1-4, and 1-5*).—The Frequency Meter is contained in a special shock-mounted case and is constructed on a shielded main chassis fastened to the front panel. A sub-chassis mounts the major heterodyne oscillator components and acts as an additional shield.

The Frequency Meter is tuned by a special variable capacitor mounted on a rugged frame and provided with a precision worm-gear drive mechanism. The mechanism, an integral part of the tuning capacitor, consists of a spring-loaded, split-gear fastened to the capacitor shaft, and a worm fastened to the tuning drive shaft. The capacitor compartment is completely enclosed and contains the low and high band trimmer capacitors as well as the main variable capacitor.

The front panel mounts the tuning capacitor and vernier dial (DIAL UNITS) assembly, and the various operating controls for the unit. An indexed window provides for reading of the main frequency dial (DIAL HUNDREDS). All power connections are made through a receptacle at the side of the unit.

Mounted beneath the main chassis are various circuit components and the hermetically-sealed, enclosed crystal. To prevent interaction between stages, the underside of the chassis is divided into sections by a shield, as shown in figure 1-4. The upper right section contains the components for the crystal oscillator and detector stages. A terminal board, mounted on the shield, is provided with links to permit operation of the Frequency Meter from voltages sources other than the Rectifier Power Unit.

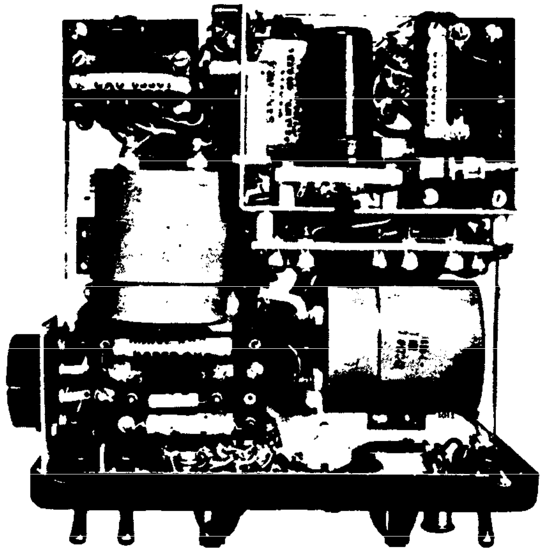


Figure 1-5. Heterodyne Frequency Meter — Bottom View, Case Removed

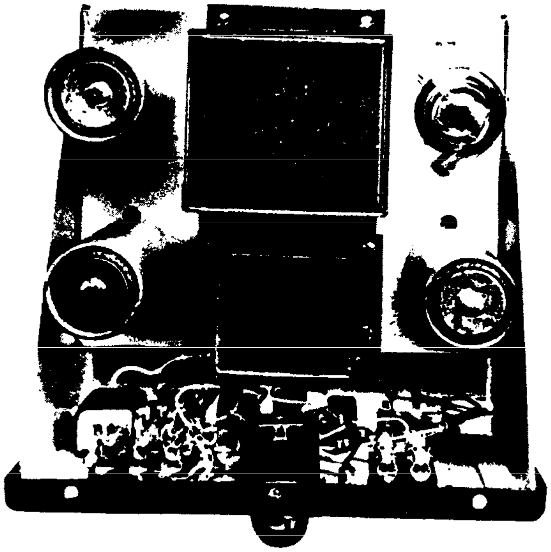


Figure 1-6. Rectifier Power Unit — Top View, Case Removed

c. TYPE CBLC-20104A RECTIFIER POWER UNIT. (*See figures 1-3, 1-6, and 1-7*).—The Rectifier Power Unit is also contained in a special shock-mounted case. The chassis contains the major circuit components, including the power transformer, rectifier, and filter units.

The front panel mounts the power input and output receptacles, power switch, line voltage compensating switches, and pilot light. The rear of the front panel contains the operating and spare fuses for the a.c. and plate supply circuits. Mounted underneath the chassis are insulated fuse clips containing the power-supply bleeder resistors.

d. TYPE CBLC-10121 FREQUENCY METER MOUNTING BASE.—The Frequency Meter Mounting Base consists of a formed rectangular frame, provided with shock-mounts at each corner. Grooved vertical studs projecting from the mounts secure the Frequency Meter in place in conjunction with two snap-slide fasteners located at the bottom of the case. The mounting studs are bonded to the base by flexible connections, for grounding of the Frequency Meter.

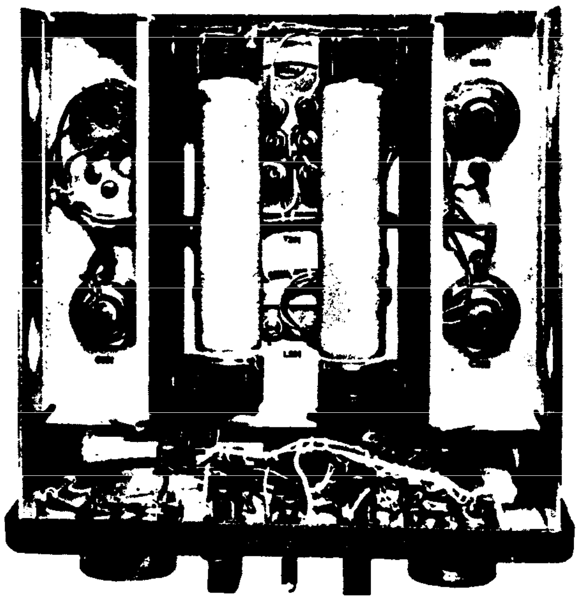


Figure 1–7. Rectifier Power Unit — Bottom View, Case Removed

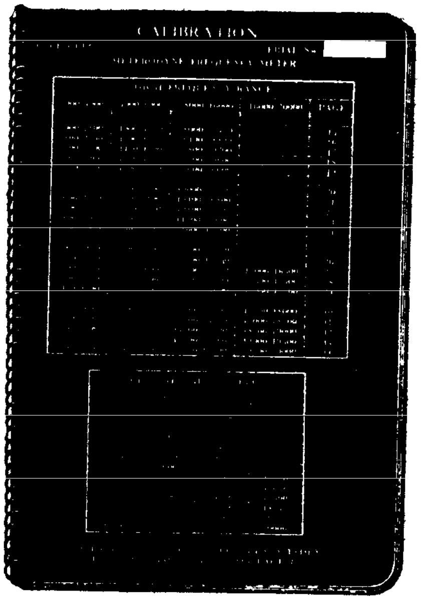


Figure 1–8. Heterodyne Frequency Meter Calibration Book

e. TYPE CBLC–10120 RECTIFIER POWER UNIT MOUNTING BASE.—The Rectifier Power Unit Mounting Base consists of two sections. The rectangular lower base is provided with horizontal grooved studs at the front and is permanently mounted; the upper base assembly is fastened to the power unit by shock-mounts at each corner. Snap-slide fasteners located at the front of the upper base lock the Rectifier Power Unit and upper base to the lower mounting base. The unit case is grounded by flexible connections to the shock-mount studs which fasten the upper base in place.

f. CALIBRATION BOOK. (*See figure 1–8*).—The Calibration Book contains the calibrated dial settings for any frequency within the operating range of the Frequency Meter, together with crystal check points for correcting the heterodyne oscillator to agree with the calibration.

The low frequency range is calibrated at each one-tenth kc., from 125 to 250 kcs.; the high frequency range is calibrated in one kc. increments, from 2000 to 4000 kcs. In addition to the fundamental frequencies, the second, fourth, and eighth harmonics are tabulated for the low frequency band, and the second, fourth, and portions of the fifth harmonic are listed for the high frequency band.

The book is spiral-bound and is stowed in a compartment at the bottom of the Frequency Meter case.

g. POWER CABLES.—Two shielded power cables, complete with connectors, are supplied with the equipment.

The power cable connecting the Rectifier Power Unit to the Frequency Meter consists of a shielded four-conductor cable terminated in a right-angle plug for the meter input receptacle, and a straight plug for the power unit output receptacle.

The a.c. input cable to the Rectifier Power Unit is made up of shielded, three-conductor cable terminated in a straight plug for the a.c. input receptacle.

9. ELECTRON TUBE COMPLEMENT.

The electron tube complements of the major units of the Model LM–18 Frequency Indicating Equipment are listed in table 1–6.

TABLE 1–6. ELECTRON TUBE COMPLEMENT.

UNIT	NUMBER OF TUBES OF TYPES INDICATED					TOTAL NUMBER OF TUBES
	JAN-77	JAN-6A7	JAN-76	JAN-991	JAN-84	
Heterodyne Frequency Meter, Type CBLC–74028	1	1	1	2	. .	5
Rectifier Power Unit, Type CBLC-20104A	. .	. .	. .	. .	1	1
Total Number of Each Type	1	1	1	2	1	6

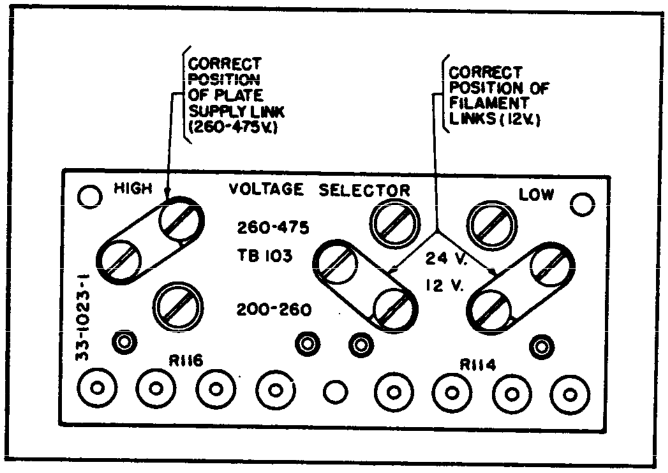

CORRECT POSITION OF PLATE SUPPLY LINK (260-475V.)
CORRECT POSITION OF FILAMENT LINKS (12V.)
HIGH
VOLTAGE SELECTOR
LOW
260-475
TB 103
200-260
24 V.
12 V.
33-1023-1
R116
R114

Figure 3–2. Type CBLC–74028 Heterodyne Frequency Meter — Voltage Link Settings

INSTALLATION.

a. TYPE CBLC–74028 HETERODYNE FREQUENCY METER.—To remove the Frequency Meter from its mounting base, release the two snapslides below the front panel by pulling them forward. Lift the unit from the mounting base. Remove the six screws along the side and top edges of the panel and the three screws across the back of the cabinet. Withdraw the chassis from the cabinet for inspection. Make sure that all tubes and the crystal holder are firmly seated in their sockets. Check the grid clips for firm contact with the grid terminals and make certain that all tubes are securely clamped.

Before reassembling the chassis and cabinet, check the settings of the low-voltage and high-voltage selector links (located on the link panel behind transformer T101). Set the two low-voltage links to 12v, and the high-voltage link to 260-475v, if necessary, as shown in figure 3–2. Reassemble the chassis in the cabinet, and replace and tighten all screws.

The Frequency Meter should be horizontally mounted with operating controls readily accessible and clearly visible to the operator. Allow one-half inch clearance for freedom of motion on the mounting base and for ventilation. Locate the Frequency Meter so that the front panel is readily accessible and at a comfortable operating height. Avoid locations where the ambient temperature is apt to be excessive.

To install the Type CBLC–74028 Heterodyne Frequency Meter proceed as follows:

(1) Locate the Type CBLC–10121 Mounting Base in the desired position. Use the base as a template and drill four 3/16" holes. If the unit is mounted on a metal surface, scrape the paint from around the holes on both upper and lower surfaces of the base. Make certain that the contact area on the mounting surface is clean and free from corrosion. Bolt the base to the supporting surface, using 10–32 roundhead screws, together with suitable lockwashers and nuts.

(2) Pull the snapslides at the bottom of the Frequency Meter forward and position the unit on the mounting studs. Press the snapslides back and check the locking of each stud by pulling upward at each of the bottom corners of the unit. Secure the snapslides with safety wire.

(3) No grounding bond is required between the meter case and the mounting base. Bonding connections are provided by flexible leads from each locking stud to the base.

b. TYPE CBLC–20104A RECTIFIER POWER UNIT.—To remove the Power Unit from the lower mounting base, release the two snapslides at the front of the upper mounting plate. Push the power supply forward and lift the unit off the lower mounting base. Remove the nine screws along the top and side edges of the panel and withdraw the chassis from the cabinet for inspection.

Inspect the chassis for possible damage incurred during shipment. Check the seating of the rectifier tube and inspect the fuses and clip-in resistors to see that they are properly mounted. The three operating fuses are located on the inner surface of the front panel, with the spare fuses in adjacent clips. The clip-in bleeder resistors are located underneath the main chassis shelf. After inspection, reassemble the chassis and cabinet, replace and tighten all screws. The unit should be mounted on a horizontal surface adjacent to the a.c. power source and within reach of the power supply cable from the Frequency Meter.

To mount the Type CBLC–20104A Rectifier Power Unit proceed as follows:

(1) Locate the Type CBLC–10120 Mounting Base in the desired position. Use the base as a template and drill six 3/16" holes. Scrape the paint from around the holes and bolt the base to the supporting surface, using 10–32 roundhead screws, together with lockwashers and nuts. Make certain that the base is mounted with the folded edges up.

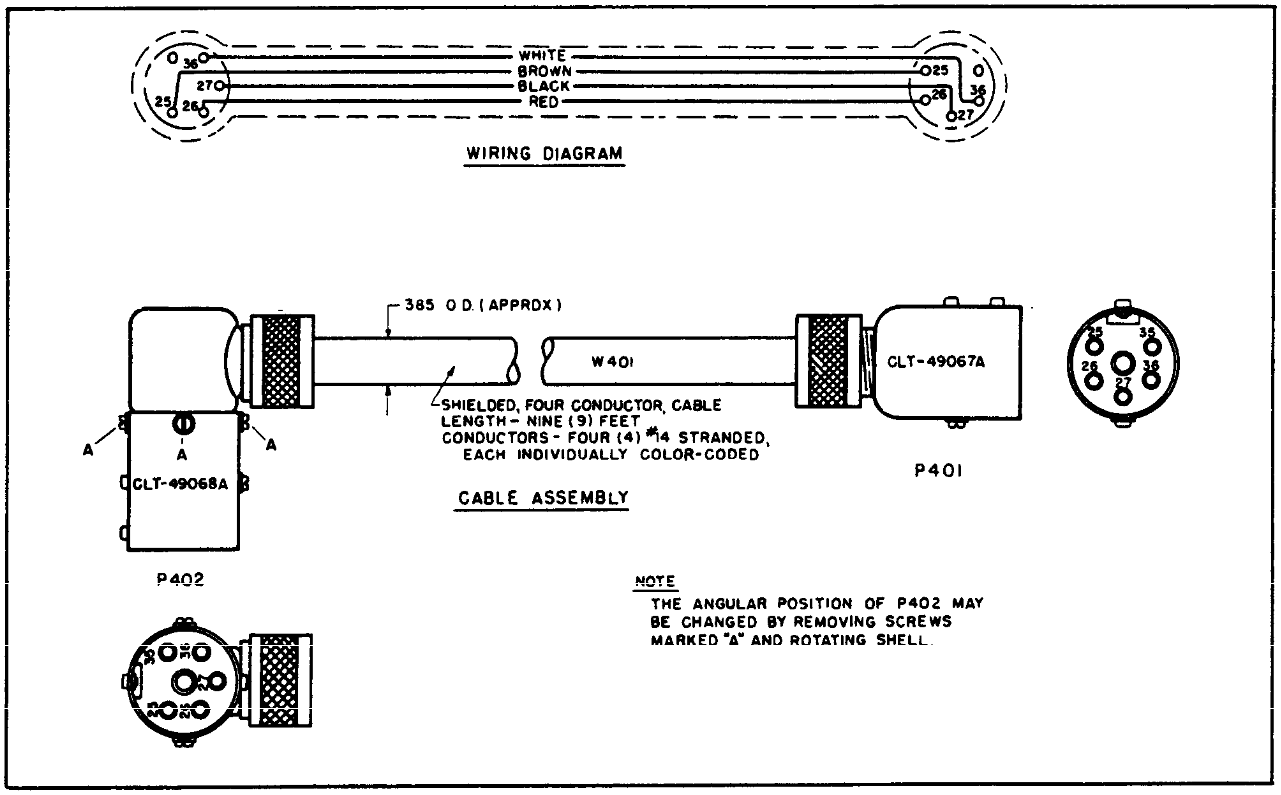
(2) Position the Power Unit on the lower mounting base, push back on the unit and engage the snapslide studs in the holes at the front edge of the base. The rear lip of the base will then engage the hold-down strip at the rear of the upper mounting base. Press the snapslides towards the studs to secure the unit, and safety wire the slides in place.

(3) A grounding bond is not required as the upper mounting base is connected to the case of the power unit by a flexible connector.

3. INTERCONNECTION OF UNITS.

a. CONNECTION BETWEEN FREQUENCY METER AND POWER UNIT.—Filament and plate power for the Frequency Meter are supplied by a shielded, four-conductor power cable terminated in a right angle plug, P302, at the Frequency Meter, and a straight plug, P303, at the Power Unit, as shown in figure 3–3. Insert P302 into the power input receptacle, J102, located at the side of the Frequency Meter. As shipped, the plug is assembled so that the power cable runs toward the rear. If this cable position is unsatisfactory, remove the four screws which secure the plug cap, turn the shell to the most convenient of the eight possible angles and replace the screws. Do not twist the shell more than one-half turn from its original position in either direction, to avoid straining or breaking the cable conductors. Plug the other end of the shielded power cable into receptacle J202 on the Power Unit.

b. CONNECTION BETWEEN POWER UNIT AND POWER SOURCE.—Power for the Type CBLC–20104A Rectifier Power Unit is obtained from a single phase, 50 to 60 cycle, a.c. line, operating at from 100 to 130 volts. Power is supplied by a three-wire shielded cable terminating in a straight plug, P303, at the Power Unit. Set the POWER switch to OFF and insert P303 into the input receptacle, J201, on the Power Unit. The cable conductors project beyond the shielding for several inches and their ends are tinned. It is recommended that these leads be connected to a Navy Type D1 plug if a removable connection is required. The black lead is the ground conductor and should be connected to a ground terminal, or, if none is accessible, to the cable shielding. For permanent installation the cable may be wired into a junction box.



NOTE
THE ANGULAR POSITION OF P402 MAY BE CHANGED BY REMOVING SCREWS MARKED "A" AND ROTATING SHELL.

Figure 3–3. Model LM–18 Equipment — Interconnecting Power Cable

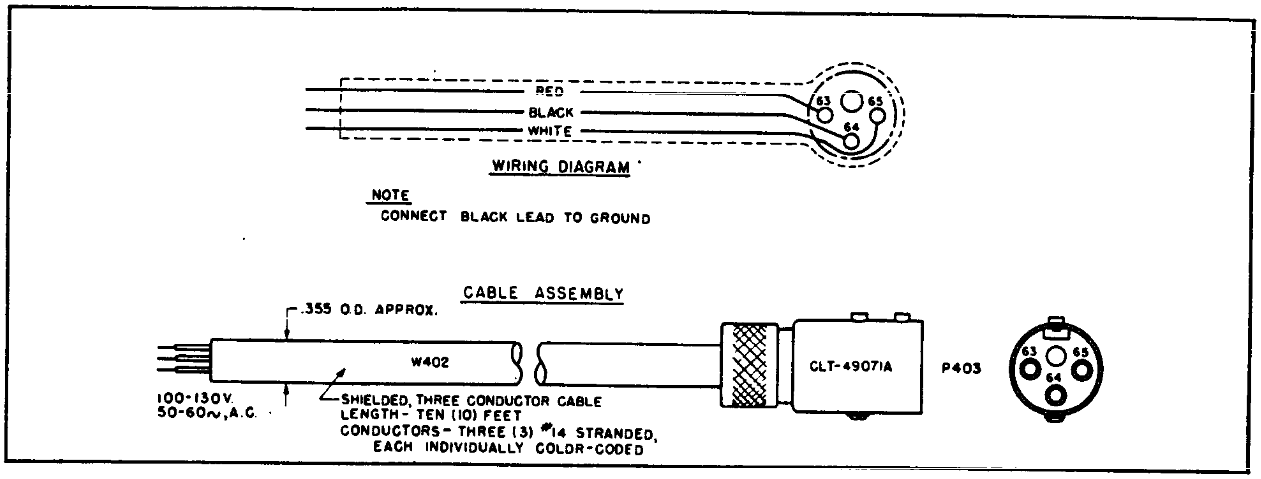


Figure 3–4. Model LM–18 Equipment — A.C. Input Cable

c. COUPLING BETWEEN FREQUENCY METER AND EQUIPMENT.—A short antenna is required for coupling to the receivers and transmitters which are to be adjusted. This should preferably be a fixed wire approximately four or five feet long, permanently mounted on stand-off insulators, and installed so that about two feet of its far end will run parallel and close to the transmitter and receiver antenna leads. Where these conditions cannot be realized, a flexible, insulated pick-up wire may be employed. Connect one end of the lead to the R.F. COUPLING terminal on the Frequency Meter. Capacitively couple the other end, by means of an insulated test clip, to the various coupling points, as desired.

WARNING

> *Never* connect the R.F. COUPLING terminal directly to any part of the transmitter or receiver whose frequency is being measured.

4. INITIAL ADJUSTMENTS.

a. POWER SUPPLY COMPENSATION.—Following installation, and prior to operation of the equipment, COMP. switches 1 and 2 on the Rectifier Power Unit must be adjusted to provide the proper input voltage to the power transformer. The Power Unit is designed for operation within the limits of 100 to 130 volts. The correct settings for the switches must be determined by the use of an 0–150 volt a.c. voltmeter, connected externally to the rectifier power unit. To set the COMP. switches, proceed as follows:

(1) Measure the line voltage by means of the voltmeter.

(2) If the reading is 110 volts or less, set both switches in the UP position.

(3) If the reading is 120 volts or greater, set switch 1 to the DOWN position and switch 2 to the UP position.

(4) If the voltage is between 110 and 120 volts, set switch 1 up and switch 2 down.

The power consumption and output voltages, for various input voltages and COMP. switch settings, is summarized in table 3–1.

The switching arrangement enables the output voltage of the power unit to be held within limits that assure frequency stability and accurate calibration of the Frequency Meter over the range of input voltages.

TABLE 3–1. COMPENSATION SWITCH SETTINGS

INPUT		COMPENSATION		COMPENSATED VOLTS	RECT. FIL. VOLTS	OUTPUT FIL. VOLTS	PLATE	
VOLTS	WATTS	1	2				VOLTS	CURRENT (MA)
130	27.3	OFF	OFF	118	6.3	12.9	292	19.9
120	19.1	OFF	OFF	108	5.9	11.9	270	17.8
120	27.0	ON	OFF	118	6.3	12.9	292	19.9
110	22.6	ON	OFF	108	5.9	11.9	270	17.8
110	27.6	ON	ON	118	6.3	12.9	292	19.9
100	22.5	ON	ON	107	5.7	11.7	264	17.1

b. PERFORMANCE TEST.—A check of the installation and performance of the Model LM-18 Crystal Calibrated Frequency Indicating Equipment may be made by operation of the equipment, utilizing the various controls for calibration and transmitter and receiver adjustment. To check the operation of the equipment, after adjusment of the COMP. switches on the Power Unit, proceed as follows:

(1) Plug a pair of low impedance headphones (600 ohms at 1000 cycles) into the PHONES jack. Set the POWER switch on the Power Unit to ON and move the FIL. and PLATE switches on the Frequency Meter to ON. Allow ten minutes for the tubes to reach stabile operating temperature.

(2) Position the Frequency Meter controls as tabulated below:

CONTROL	LETTER	POSITION
MODULATION	A	OFF
FREQ. BAND	B	LOW
R.F. COUPLING	C	Not used
TUNING DIAL	D	As required
CORRECTOR	E	Midpoint

(3) Set the tuning dial to the reading indicated at the bottom of page 2 of the calibration book, for the lowest crystal check point. As the dial is rotated, a series of beat notes of varying intensity, between the crystal and heterodyne oscillators, should be heard in the phones.

(4) With the heterodyne oscillator tuning dial set to the indicated crystal check point, adjust the frequency to coincide exactly with that of the crystal oscillator by rotating the CORRECTOR control. Adjust for zero beat as heard in the phones. No control of audio volume level is provided in the Frequency Meter.

(5) Continue checking the Frequency Meter at successive crystal check points for the entire low-frequency band, following the procedure of step (4).

(6) Note that comparison between the crystal and heterodyne oscillators may be made at many points over the calibrated range through the employment of the fundamental or harmonic frequencies of either or both oscillators.

(7) Move the FREQ. BAND switch to the HIGH position. Set the tuning dial to the reading indicated at the bottom of page 15 of the calibration book, for the lowest high-frequency band crystal check point. Adjust the CORRECTOR dial as in step (3).

(8) Complete checking operation of the Frequency Meter at successive crystal check points for the entire high-frequency band.

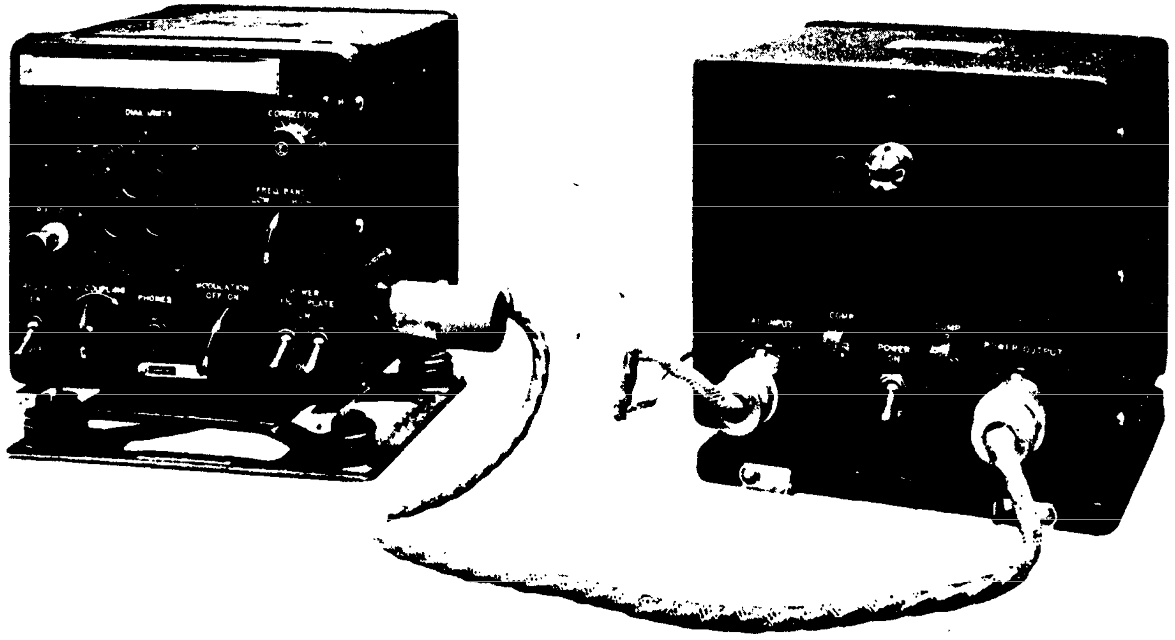


Figure 3–5. Model LM–18 Equipment — Installation Diagram

(9) It may be found that the heterodyne oscillator cannot be corrected to agree with the calibration, particularly if the frequency meter is installed in a locality where either extreme condition of humidity prevails. Under such conditions it becomes necessary to reset the heterodyne oscillator trimmer capacitors, C103 and C104. The ends of the trimmer adjusting shafts are located behind the L and H cover plates in the upper right hand corner of the panel. To make these adjustments, proceed as indicated in the following paragraph.

c. READJUSTMENT OF HIGH AND LOW BAND TRIMMERS.—Readjustment of the heterodyne trimmer capacitors is required upon completion of the performance test if the heterodyne oscillator cannot be corrected to coincide with the calibration by means of the CORRECTOR control. A screwdriver is required for adjustment of the trimmers. To set the capacitors, proceed as follows:

(1) Place the Frequency Meter in operation, with the FREQ. BAND switch set to LOW and the MODULATION switch to OFF. Allow the Frequency Meter to warm up for a period of ten minutes.

(2) Set the DIAL UNITS and DIAL HUNDREDS scales to agree with the reading given for 250 kcs. on page 14 of the calibration book. Set the CORRECTOR dial at midscale (4.5 divisions).

(3) After making certain that the dials are set correctly, move the cover plate up and insert the screwdriver through the L hole in the panel. Rotate the trimmer capacitor, C103, toward the right while listening in the phones, until the heterodyne oscillator is set to zero beat with the crystal calibrator.

(4) Check the ability of the CORRECTOR to reset the heterodyne oscillator to zero beat at all crystal check points listed on the back cover of the calibration book.

(5) If the Frequency Meter cannot be corrected at all crystal check points in the LOW band, with the trimmer adjustment that was made with the CORRECTOR knob set at 4.5 divisions at 250 kcs., repeat the procedure outlined in steps (3) and (4) with the CORRECTOR knob set to six divisions (6.0), at 250 kcs.

(6) By such progression, a setting of the L trimmer will be found where it is possible to reset the Frequency Meter to zero beat at all crystal check point readings given for the LOW band in the calibration book, by means of the CORRECTOR control.

(7) Replace the L trimmer cover and repeat the above procedure with the FREQ. BAND switch set to HIGH, and the DIAL UNITS and DIAL HUNDREDS scales set to agree with the reading given for 4000 kcs. on page 34 of the calibration book. Adjust the trimmer capacitor, C104, to the position which enables the CORRECTOR control to reset the heterodyne oscillator to zero beat at all crystal check points listed for the HIGH band.

OPERATION

1. GENERAL.

The Model LM–18 Crystal Calibrated Frequency Indicating Equipment is designed to provide an accurate means of adjusting the frequency of transmitters and receivers in the range from 125 to 20,000 kcs. The equipment consists of a crystal-calibrated frequency meter and a power supply unit.

The Type CBLC–74028 Heterodyne Frequency Meter contains a crystal oscillator, heterodyne oscillator, high-gain detector, and audio amplifier. The heterodyne oscillator is calibrated in two bands, from 125 to 2000 kcs., and from 2000 to 20,000 kcs. The crystal oscillator enables correction of the calibration, as tabulated for individual units and listed in a calibration book. The correction may be made at various frequencies which are fundamentals or harmonics of either or both oscillators. Calibration is effected by zero-beating the oscillators, using the detector, audio amplifier, and headphones to determine null conditions, at the nearest crystal check point to the desired frequency. The heterodyne oscillator serves as an accurate signal source for comparison with an unknown signal, for transmitter adjustment, or as an unmodulated or AM-modulated signal generator, for receiver calibration. For modulated signal output, the audio amplifier is switched to act as a modulator.

The Type CBLC–20104A Rectifier Power Unit supplies plate and filament voltages for the Frequency Meter and operates at a nominal voltage of 115 volts, 50 to 60 cycles, a.c. Compensation is provided for line voltages which may be higher or lower than the nominal value.

The Model LM–18 Equipment is capable of providing accuracies of 0.02 percent in the low frequency band, and 0.01 percent in the high frequency band, over wide ranges of ambient temperature. These accuracies are for a combination of temperature, humidity, and voltage variation, and under normal use will be better than the extremes quoted. A voltage stabilizing circuit, used in conjunction with the heterodyne oscillator, aids in maintaining the indicated accuracy despite line voltage fluctuations.

2. FUNCTIONS OF CONTROLS.

a. TYPE CBLC–74028 HETERODYNE FREQUENCY METER.—The Frequency Meter is provided with eight operating controls, five of which are switches. The location of the controls is illustrated in figure 4–1; the function of each control is detailed in table 4–1.

The front panel of the Frequency Meter contains an output PHONES jack, and R.F. COUPLING terminal, a calibration card, and two swinging cover plates which provide access to the low and high band trimmer capacitors. The coupling terminal provides means of coupling an input signal in parallel with the heterodyne oscillator or of feeding the output of the oscillator (modulated or unmodulated) to a receiver.

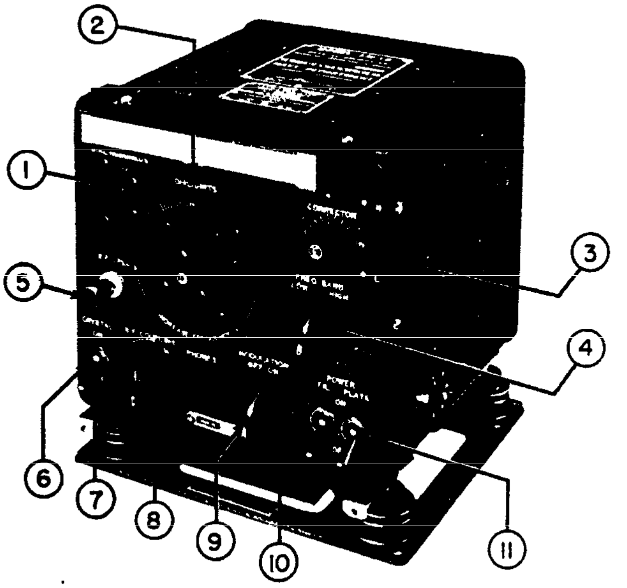


Figure 4–1. Heterodyne Frequency Meter — Operating Controls

b. TYPE CBLC–20104A RECTIFIER POWER UNIT.—The Power Unit is provided with a single operating switch and two preset line compensation switches. The location of the switches is shown in figure 4–2.

TABLE 4-1. FUNCTION OF OPERATING CONTROLS

DESIGNATION	TYPE	FIG. REF.	FUNCTION
FIL. POWER ON-OFF	Switch	10	Energizes both filament and plate circuits.
PLATE POWER ON-OFF	Switch	11	Energizes plate circuits; used for standby operation.
CRYSTAL ON-OFF	Switch	6	Energizes crystal oscillator.
MODULATION OFF-ON	Knob A	9	Controls operation of V103; in OFF position, V103 acts as an audio amplifier, for calibration and transmitter adjustment; in ON position V103 operates as a 500-cycle modulator, for AM-modulated signal output.
FREQ. BAND LOW-HIGH	Knob B	4	Selects operating range of heterodyne oscillator; low frequency band from 125 to 2000 kcs., or high frequency band from 2000 to 20,000 kcs.
R.F. COUPLING	Knob C	7	Controls input signal level for transmitter adjustment; adjusts output signal level for receiver calibration.
DIAL UNITS DIAL HUNDREDS	Dial D	2, 1	Tunes heterodyne oscillator and provides accurate reading of dial setting.
CORRECTOR	Knob E	3	Corrects frequency of heterodyne oscillator to agree with calibration, at nearest crystal check point to desired frequency.

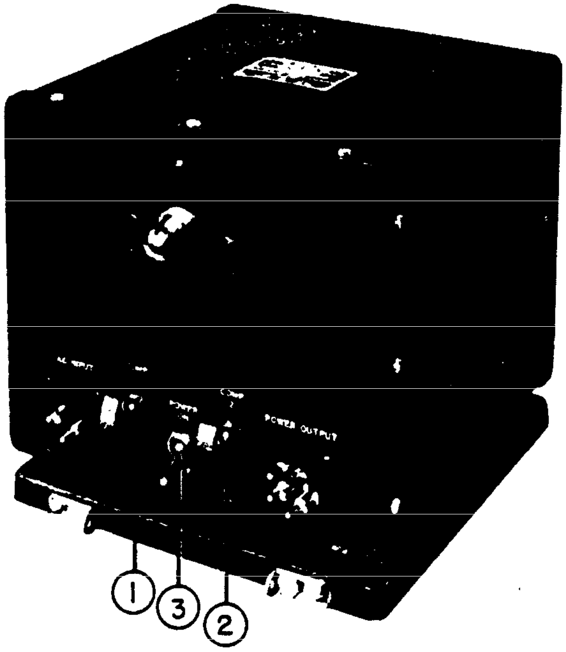


Figure 4-2. Rectifier Power Unit — Operating Controls

The POWER switch (3) energizes the power supply and acts as a master switch for the Model LM-18 Equipment. The position of the COMP. switches (1 and 2) are adjusted during installation to compensate for the a.c. line input voltage and should not be reset by operating personnel.

3. CORRECTING TO CALIBRATION.

a. GENERAL.—Before any frequency adjustments may be made, the heterodyne oscillator must always be corrected to calibration, through comparison with the crystal oscillator at the crystal check point nearest to the desired frequency. Comparison between the crystal and heterodyne oscillators may be made at many points over the calibrated range through use of the fundamental or harmonic frequencies of either or both oscillators. Comparison between the two oscillators is effected by setting the heterodyne oscillator tuning control to the scale reading corresponding to the crystal check point desired, and noting the resulting beat note heard in a pair of headphones plugged into the PHONES jack.

b. DIAL SETTING.—The tuning dial of the heterodyne oscillator is marked in DIAL HUNDREDS and DIAL UNITS. The DIAL HUNDREDS scale ranges

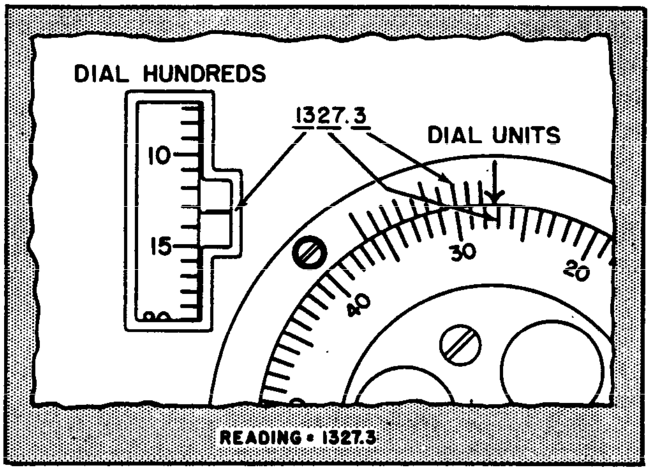


Figure 4–3. Heterodyne Frequency Meter — Dial Setting

from 0 to 50 divisions: the DIAL UNITS scale covers from 0 to 100 divisions. A vernier scale, adjacent to the DIAL UNITS scale, enables setting the dial to tenths of a unit division. Dial readings printed in the calibration book consist of three or four digits followed by a single decimal figure. To set the heterodyne oscillator to a particular frequency, proceed as follows:

(1) Note the number of digits in the dial reading at the desired frequency, as printed in the calibration book.

(2) Rotate the tuning dial until the DIAL HUNDREDS reading is equal to the first, or the first and second digits, for numbers below or above 1000 respectively. Set the DIAL UNITS reading to the last two digits and continue rotation of the tuning dial until the vernier scale division corresponding to the decimal portion of the printed figure coincides with the nearest dial scale division.

(3) For example, to set the heterodyne oscillator to a dial reading of 1327.3, set the DIAL HUNDREDS scale to 13 and the DIAL UNITS scale to 27. Continue rotation of the dial until the third vernier division coincides with the nearest adjacent dial division, as shown in figure 4–3.

c. PROCEDURE.—To correct the heterodyne oscillator, prior to use at any desired frequency within the range of calibration, proceed as follows:

(1) From the HIGH or LOW frequency indices on the front and rear covers of the calibration book, determine in which band the desired frequency is located and set the FREQ. BAND switch to correspond.

(2) From the frequency indices, determine on which page the desired frequency is listed, and turn to this page. The crystal check point nearest the desired frequency, together with its dial setting, will be found printed in red at the bottom of the page.

(3) Set the CRYSTAL and POWER switches to the ON position; turn the MODULATION switch to OFF, and plug in the headphones, as indicated in figure 4–4.

(4) Set the heterodyne oscillator tuning dial to the indicated crystal check point reading. One or more beat notes will be heard in the phones as the adjustment is made.

(5) Adjust the CORRECTOR control to produce zero beat at the strongest beat point within its range. After the operator has become familiar with the equipment, it will be found that this adjustment can be made precisely to practically zero beat.

(6) If no beat notes are heard the cause may be either a defective Frequency Meter or the heterodyne oscillator may be so far off calibration that the beat frequency is above audibility.

(7) When corrected, the frequency of the heterodyne oscillator will agree with the calibration (to within the reset accuracies previously noted) throughout the range of frequencies included on all the pages to which the particular crystal check point applies, provided the ambient temperature remains constant, and the filament and/or plate supply voltage do not vary by more than ten percent.

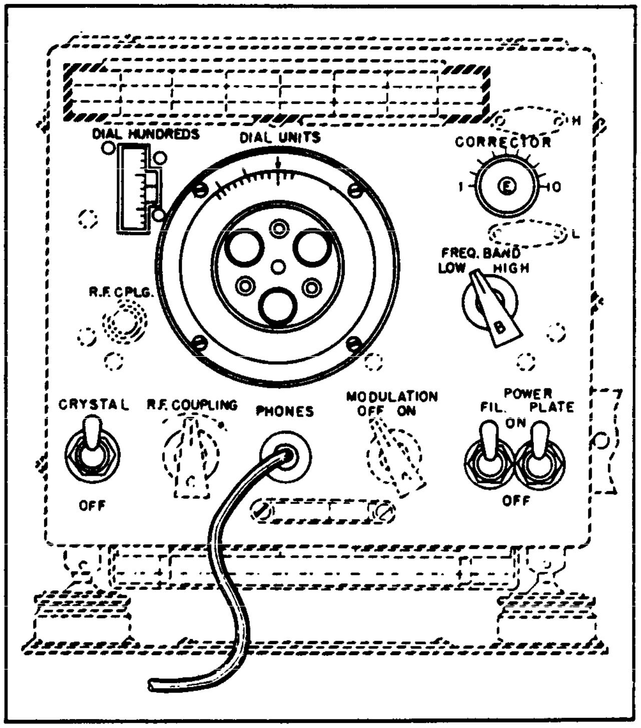


Figure 4–4. Heterodyne Frequency Meter — Calibration Control Settings

d. BEAT POINT IDENTIFICATION.—Due to the presence of fundamental and harmonic frequencies generated by both crystal and heterodyne oscillators, when correcting to calibration numerous beat points will occur which are not listed as crystal check points in the calibration book. In most cases the intensity of these unlisted beat points is relatively low. To avoid confusion as to the actual crystal check points, the beat points encountered at the various lowest harmonic combinations of the two oscillators are given in table 4–2. The relative outputs at the indicated beat points are illustrated in figure 4–5 and also listed in table 4–2. The calibration crystal check points are marked in bold-face type in the table.

Under actual operating conditions, those beat points which are listed as very weak and many of those listed as weak (levels of five milliwatts or less) will probably not be heard. As evidenced by the tabulation of beat points, two or more beats may be heard over the range of variation of the CORRECTOR control, when calibrating at a given crystal check point. Obtain the correct beat point by adjusting to zero beat for the strongest signal at the selected dial setting.

TABLE 4–2. FREQUENCY METER CALIBRATION BEAT POINTS

LOW BAND			
BEAT PT. (HET. OSC. FUND. FREQ.)	LOWEST HET. OSC. HARMONIC	LOWEST CRY. OSC. HARMONIC	RELATIVE OUT-PUT
125.00	8	1	S
128.21	39	5	W
129.03	31	4	W
130.43	23	3	W
131.57	38	5	W
133.33	15	2	S
135.13	37	5	W
136.36	22	3	W
137.93	29	4	W
138.88	36	5	VW
142.86	7	1	S
147.05	34	5	W
148.14	27	4	W
150.00	20	3	W
151.51	33	5	W
153.84	13	2	S
156.25	32	5	W
157.89	19	3	W
160.00	25	4	W
161.29	31	5	W
166.67	6	1	S
172.41	29	5	W
173.91	23	4	W
176.47	17	3	S
178.57	28	5	W
181.81	11	2	W
185.18	27	5	W
187.50	16	3	S
190.47	21	4	W
192.31	26	5	W
200.00	5	1	S
208.33	24	5	W
210.53	19	4	W
214.28	14	3	S
217.39	23	5	W
222.22	9	2	S
230.76	13	3	S
235.29	17	4	S
238.09	21	5	W
250.00	4	1	S

VW — VERY WEAK
W — WEAK
S — STRONG
VS — VERY STRONG

HIGH BAND			
BEAT PT. (HET. OSC. FUND. FREQ.)	LOWEST HET. OSC. HARMONIC	LOWEST CRY. OSC. HARMONIC	RELATIVE OUT-PUT
2000	1	2	VS
2125	8	7	W
2143	7	15	S
2166	6	13	S
2200	5	11	S
2250	4	9	S
2286	7	16	W
2333	3	7	VS
2375	8	19	W
2400	5	12	S
2428	7	17	W
2500	2	5	VS
2571	7	18	W
2600	5	13	S
2625	8	21	W
2667	3	8	VS
2714	7	19	W
2750	4	11	S
2800	5	14	S
2833	6	17	W
2857	7	20	W
2875	8	23	VW
3000	1	3	VS
3125	8	25	W
3143	7	22	W
3167	6	19	W
3200	5	16	S
3250	4	13	S
3286	7	23	W
3333	3	10	S
3375	8	27	VW
3400	5	17	W
3420	7	24	VW
3500	2	7	VS
3571	7	25	VW
3600	5	18	W
3625	8	29	VW
3667	3	11	S
3714	7	26	VW
3750	4	15	S
3800	5	192	W
3833	6	23	W
3857	7	27	VW
3875	8	31	VW
4000	1	4	VS

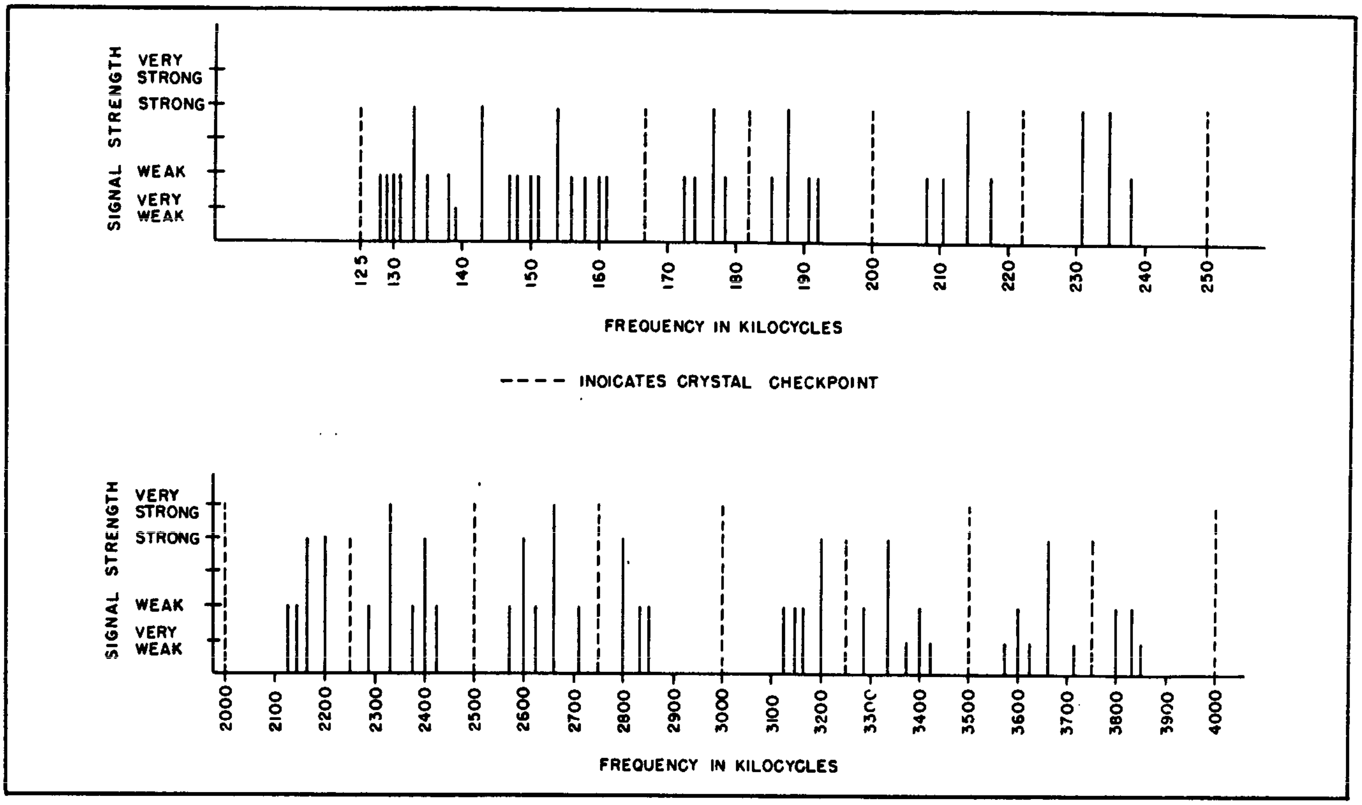


Figure 4–5. Heterodyne Frequency Meter — Beat Points

4. TRANSMITTER ADJUSTMENT.

a. GENERAL.—Adjustment of a transmitter to a particular frequency involves zero beating the transmitter signal with the proper heterodyne oscillator frequency. Null indication is provided by use of the headphones, in the same manner as for calibration to a crystal check point.

b. PROCEDURE.—To adjust the transmitter, proceed as follows:

(1) Set the Frequency Meter controls as indicated in figure 4–4 and correct the heterodyne oscillator to calibration at the crystal check point nearest the desired frequency, as outlined in paragraph 3. of this section.

(2) Turn the CRYSTAL switch to OFF.

(3) Turn the Frequency Meter tuning control to the dial setting of the desired frequency, as listed in the calibration book. If the desired frequency is in the calibrated range but not listed in the calibration book, use the interpolation table printed on the inside of the back cover of the book. Do not disturb the corrector adjustment made in step (1).

(4) Set the transmitter to the approximate frequency desired by reference to its dial calibration or calibration chart.

(5) With the Frequency Meter pick-up lead loosely coupled to the transmitter output, tune the transmitter to give an audible beat in the phones.

(6) Adjust the R.F. COUPLING control to obtain a comfortable signal level in the headphones.

(7) Tune the transmitter to zero beat with the frequency meter.

NOTE

Steps (2) through (7) should be accomplished in the shortest possible interval following calibration to prevent possible drift of the heterodyne oscillator due to voltage or temperature variations. This applies to all subsequent methods of using the Model LM–18 equipment outlined in the following paragraphs.

5. RECEIVER ADJUSTMENT

a. GENERAL.—Adjustment of a receiver to a desired frequency involves tuning the receiver to zero beat with the signal from the heterodyne oscillator. Null indication is provided by headphones in the output circuit of the receiver. The output of the Frequency Meter may be unmodulated (CW) or AM-modulated (MCW), depending on the type of signal received.

b. PROCEDURE.—To tune a CW receiver to a desired frequency, proceed as follows:

(1) Correct the heterodyne oscillator to calibration at the crystal check point nearest the desired frequency, as explained in paragraph 3.

(2) Turn the CRYSTAL switch to OFF, and transfer the phones from the Frequency Meter to the receiver output jack, as shown in figure 4–6.

(3) Turn the Frequency Meter tuning control to the dial setting of the desired frequency, as given in the calibration book. If the desired frequency is within the calibrated range, but not listed in the calibration book, use the interpolation table printed on the inside of the back cover of the book. Do not disturb the CORRECTOR adjustment as made in step (1).

(4) Turn the MODULATION switch to the OFF position.

(5) Set the receiver to the approximate frequency desired by reference to the dial calibration or calibration chart of the receiver.

(6) With the Frequency Meter pick-up lead loosely coupled to the receiver antenna lead, tune the receiver to give an audible signal in the phones.

(7) Adjust the R.F. COUPLING control to obtain a comfortable signal level in the headphones.

(8) Adjust the receiver tuning to obtain zero beat.

To tune an MCW receiver to a desired frequency, proceed as follows:

(1) Repeat steps (1), through (7) above, as for a CW receiver, with the MODULATION switch at ON.

(2) Tune the receiver for maximum signal in the headphones.

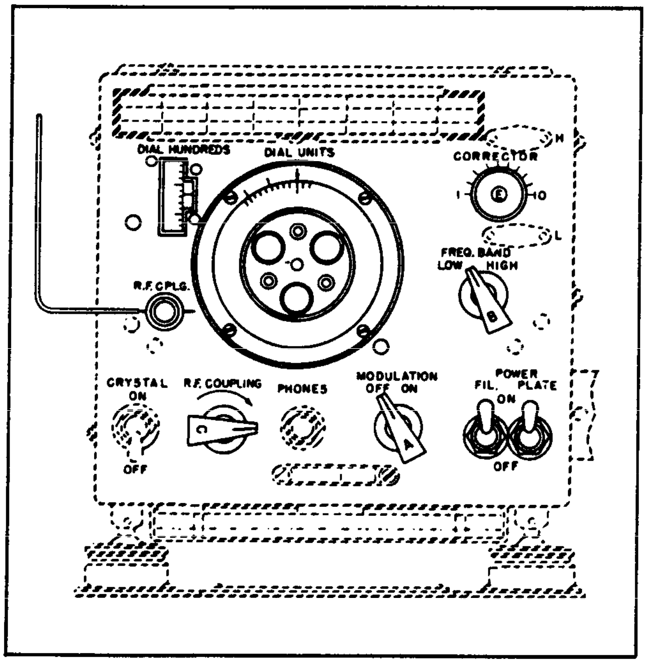


Figure 4–6. Heterodyne Frequency Meter — Receiver Adjustment Control Settings

6. FREQUENCY MEASUREMENT.

a. GENERAL.—The Model LM-18 Crystal Calibrated Frequency Indicating Equipment may also be employed for accurately measuring a frequency emitted from an external source, whether it be of local or remote origin, provided that the frequency lies within the calibrated range.

The method of using the equipment as a frequency meter varies with the location and type of signal source.

b. PROCEDURE.—In order to accurately measure an unknown signal from a nearby transmitter or oscillator, its approximate frequency must be known. Proceed as follows:

(1) Correct the heterodyne oscillator to the crystal check point nearest the approximate frequency.

(2) Turn the CRYSTAL switch to OFF.

(3) Loosely couple the pick-up lead to the signal source.

(4) Rotate the tuning control to zero beat with the incoming signal. Use the R.F. COUPLING control to adjust the signal level in the headphones.

(5) Read the frequency corresponding to this dial setting from the appropriate frequency column in the calibration book. If the dial setting is not in the calibration book, use the interpolation table on the inside back cover of the calibration book.

(6) If the approximate frequency of the signal source is unknown, use an absorption-type wavemeter or a receiver for the first approximation. Measure the actual frequency as indicated in steps (1) through (5).

When the signal whose frequency is to be determined originates at a remote point, use the following procedure:

(1) Tune in the signal on a receiver and note the approximate frequency from the receiver calibration.

(2) If the unknown signal is CW, accurately tune the receiver to zero beat. If the signal is MCW, accurately tune the receiver for maximum output. Retain the setting of the receiver tuning dial unchanged.

(3) Correct the heterodyne oscillator to calibration at the nearest crystal check point to the approximate frequency as determined from the receiver calibration.

(4) Replace the phones in the receiver output jack, loosely couple the Frequency Meter to the receiver antenna, and turn the Frequency Meter tuning control until a signal is heard in the phones.

(5) For CW signals, tune the Frequency Meter for zero beat with the receiver. Retain the MODULATION switch at OFF.

(6) For MCW signals, tune the Frequency Meter for maximum output, after setting the MODULATION switch to ON.

(7) Read the signal frequency from the appropriate column in the calibration book. If the dial setting of the Frequency Meter is in the calibrated range but not listed in the book, use the interpolation table on the inside back cover of the calibration book to find the correct frequency.

7. SUMMARY OF OPERATION.

a. A summary of the operating instructions is included below and repeated for convenience on the inside front cover of the calibration book. Observe the following precautions to assure rapid, accurate operation of the equipment.

(1) The CRYSTAL switch should always be OFF except when correcting to a crystal check point.

(2) Make certain that the FREQ. BAND switch is in the correct position; LOW for frequencies from 125 to 2000 kcs.; HIGH for frequencies from 2000 to 20,000 kcs.

(3) The MODULATION switch should always be OFF except when tuning an MCW receiver to the Frequency Meter. The phones are disconnected when the MODULATION switch is ON.

b. To tune a transmitter to a desired frequency:

(1) Plug phones into Frequency Meter jack.

(2) Find page in the calibration book showing dial setting for desired frequency.

(3) With CRYSTAL switch ON, turn Frequency Meter dial to setting for crystal check point printed in red at bottom of page.

(4) Adjust CORRECTOR to obtain zero beat in the phones.

(5) Turn CRYSTAL SWITCH to OFF.

(6) Turn Frequency Meter dial to setting for desired frequency.

(7) With transmitter coupled loosely to the Frequency Meter, tune transmitter to obtain an audible signal in the phones.

(8) Adjust R.F. COUPLING control to obtain sufficient signal.

(9) Tune transmitter to obtain zero beat in the phones.

c. To tune a CW receiver to a desired frequency:

(1) Adjust Frequency Meter to nearest crystal check point, as outlined above.

(2) Turn the Frequency Meter dial to setting for desired frequency.

(3) Remove the phones from Frequency Meter, and plug into receiver output jack.

(4) With receiver coupled loosely to the Frequency Meter, tune receiver to obtain an audible signal in the phones.

(5) Adjust R.F. COUPLING control to obtain sufficient signal.

(6) Tune receiver to obtain zero beat in the phones.

d. To tune an MCW receiver to a desired frequency:

(1) Adjust the Frequency Meter to nearest crystal check point as outlined above.

(2) Turn Frequency Meter dial to setting for the desired frequency.

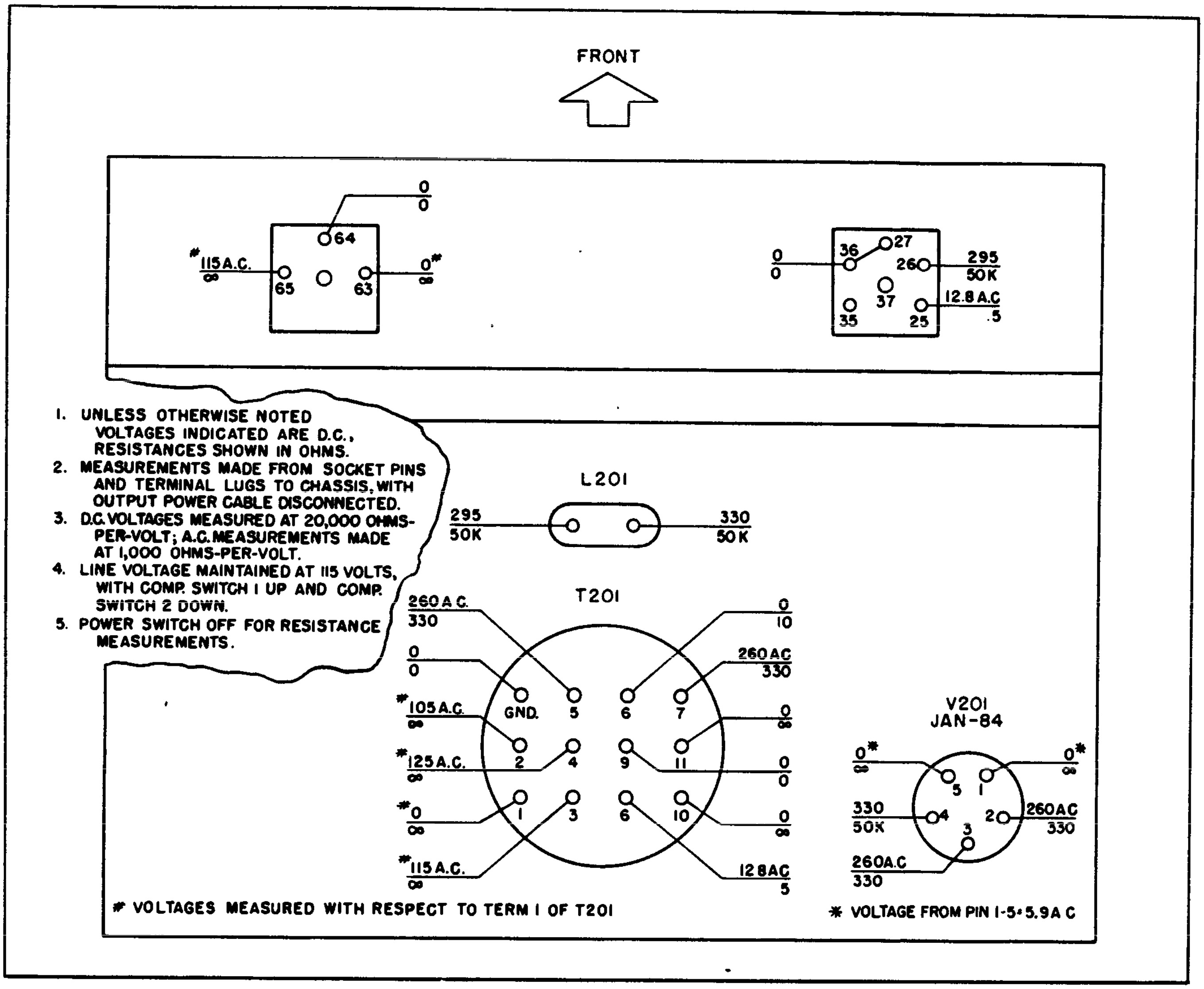
(3) Remove phones from Frequency Meter jack and plug into receiver output jack.

(4) Turn MODULATION switch ON.

(5) With the receiver coupled loosely to the Frequency Meter, tune receiver to obtain an audible signal in the phones.

(6) Adjust R.F. COUPLING control to obtain sufficient signal.

(7) Tune receiver for maximum signal.



1. UNLESS OTHERWISE NOTED VOLTAGES INDICATED ARE D.C., RESISTANCES SHOWN IN OHMS.
2. MEASUREMENTS MADE FROM SOCKET PINS AND TERMINAL LUGS TO CHASSIS, WITH OUTPUT POWER CABLE DISCONNECTED.
3. D.C. VOLTAGES MEASURED AT 20,000 OHMS-PER-VOLT; A.C. MEASUREMENTS MADE AT 1,000 OHMS-PER-VOLT.
4. LINE VOLTAGE MAINTAINED AT 115 VOLTS, WITH COMP. SWITCH 1 UP AND COMP. SWITCH 2 DOWN.
5. POWER SWITCH OFF FOR RESISTANCE MEASUREMENTS.

VOLTAGES MEASURED WITH RESPECT TO TERM 1 OF T201

✱ VOLTAGE FROM PIN 1-5•5.9A C

Rectifier Power Unit—Voltage and Resistance Diagram, Tube Socket and Components

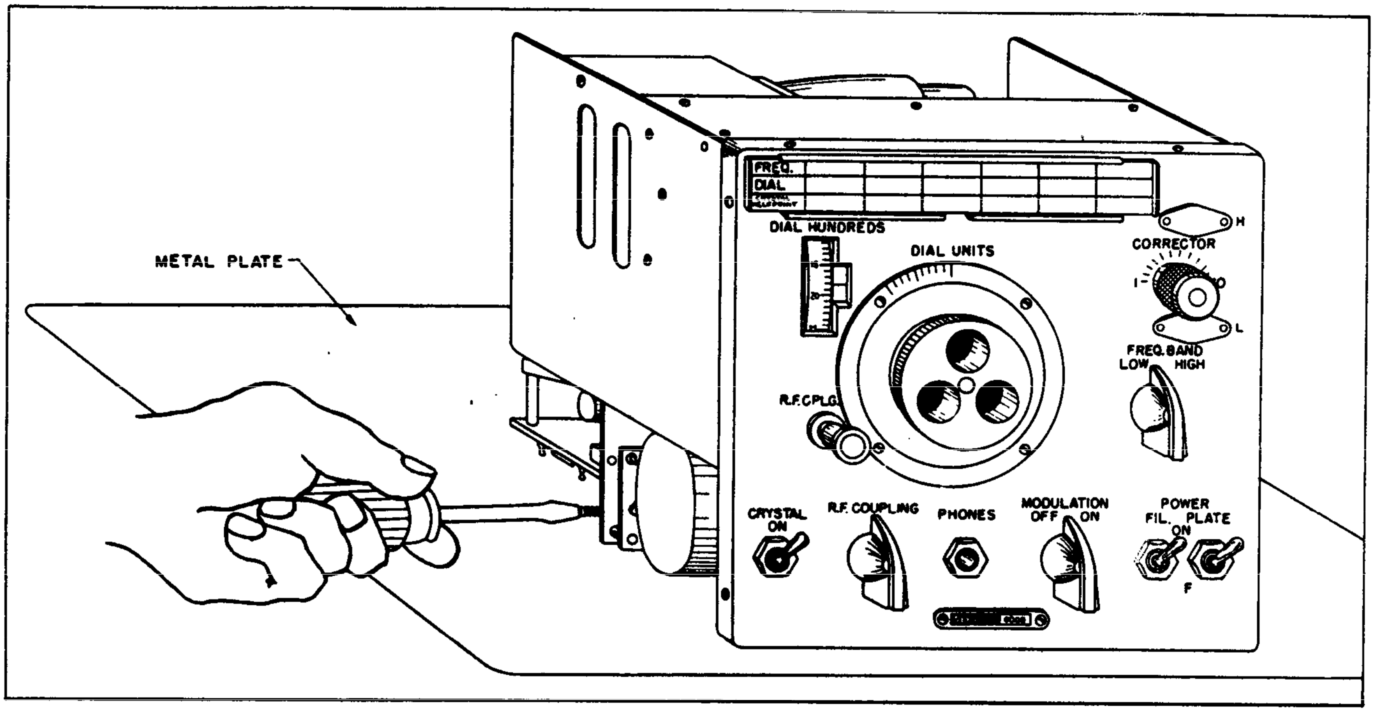


Figure 7–5. Heterodyne Frequency Meter — Adjustment of Crystal Trimmer

REPAIR.

(1) ELECTRICAL ADJUSTMENTS.—Replacement of parts in the power and audio circuits of the Frequency Meter will not require recalibration of the unit. Replacement of V101 and V102 may require readjustment of the heterodyne trimmer capacitors, C103 and C104, as outlined in Section 3, paragraph 4. Replacement of components associated with the tuned circuits of the heterodyne oscillator, including the coils and capacitors, will necessitate recalibration of the Frequency Meter, to maintain the specified accuracy. Recalibration requires return of the unit to a repair facility having the necessary equipment.

(*a*) Crystals may be replaced in the field without requiring adjustment of the crystal trimmer capacitor, C118. The resulting accuracy will still be within normal tolerance, even though maximum use is not made of the adjustable feature of the trimmer if a frequency standard is not available. The accuracy will be maintained for variations in temperature, humidity, and voltage. Adjustment of the crystal trimmer should not be undertaken unless it has been definitely ascertained that excessive error exists, and then only when the necessary equipment and personnel are available.

(*b*) If it is necessary to replace crystals in the field, the frequency of the crystal oscillator may be adjusted more closely to 1000 kcs. absolute by means of the crystal trimmer. This adjustment is possible provided there is available a frequency standard of acceptable accuracy (at least 0.0005%). The standard-frequency transmissions of the National Bureau of Standards station WWV are accurate to better than one part in 10,000,000. Station WWV operates on the following schedules:

Frequency	Hours	Modulation
2.5 mc.	2300–1300 GMT	440 cps., 1-second pulses
5.0 mc.	Continuously	4000 cps., 440 cps., 1-second pulses.
10.0 mc.	Continuously	4000 cps., 440 cps., 1-second pulses.
15.0 mc.	1100–2300 GMT	4000 cps. [illegible] 1-second pulses.

The transmissions from Station WWV [illegible] used as the frequency standard for adjustment of C118.

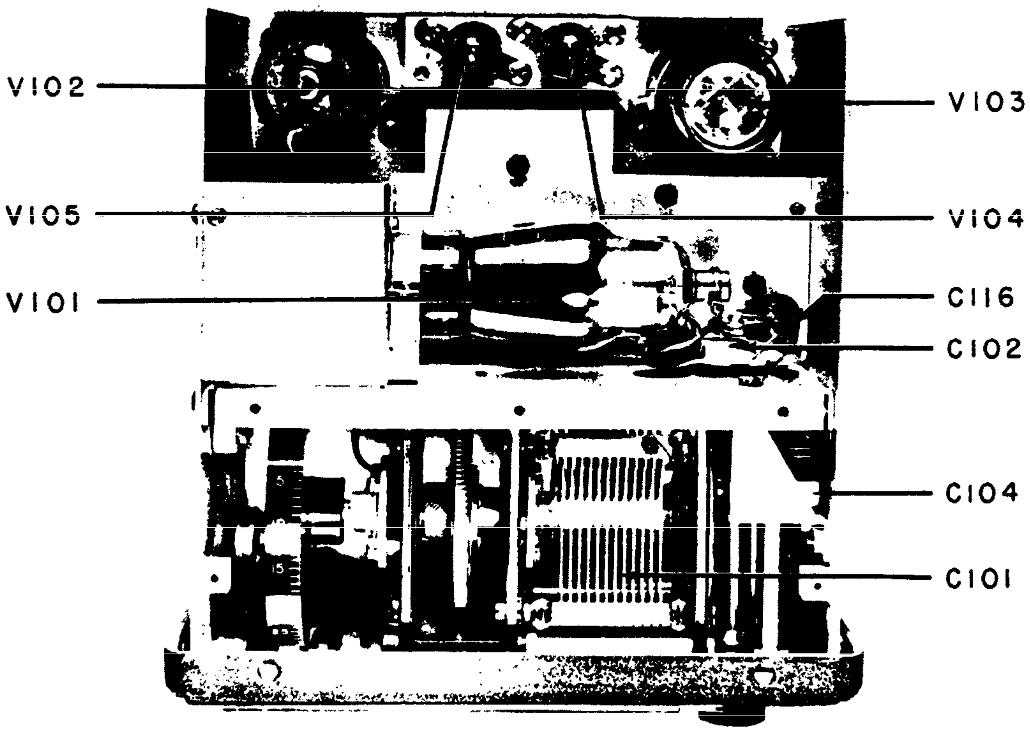


Figure 7-6. Heterodyne Frequency Meter — Location of Components, Top View of Chassis

(*c*) To replace or interchange crystals, proceed as follows:

1. Remove the Frequency Meter chassis and set it in an upright position on a bench or table top, as shown in figure 7-5. A square of sheet metal somewhat larger than the unit should be placed under the chassis so that the crystal oscillator circuit will be in the same relative position with respect to ground as it is when normally operated in the cabinet.

2. Turn the PLATE, FIL., and CRYSTAL switches to their ON positions and let the Frequency Meter warm up for at least fifteen minutes. Be sure that the MODULATION switch is in the OFF position. The FREQ. BAND switch may be in either position.

3. Connect the R.F. COUPLING terminal to a receiver which is tuned to a frequency standard or couple to the receiver with a wire placed near the crystal oscillator circuit.

4. Obtain a beat note in the output of the receiver, which has been previously tuned to 1000 kcs., and also coupled to the frequency standard. Snap the CRYSTAL switch to its OFF position. If the signal does not disappear, the heterodyne frequency oscillator is beating with the standard instead of the crystal oscillator. In this event, detune the heterodyne oscillator by turning the Frequency Meter dial to a point on the scale at which no signal is heard. Then turn the CRYSTAL switch to its ON position and adjust the receiver sensitivity until the signal from the crystal oscillator is heard. It may be necessary to disable the heterodyne oscillator by disconnecting the grid clip on V101, to prevent interference.

5. With the reception of a loud signal, insert a screw-driver in the head of the slotted screw of the crystal trimmer capacitor and adjust in such a direction that the pitch of the beat note decreases. After the beat note has been reduced to as near zero as possible, lock the screw in position by the application of a small amount of insulating varnish to the threads.

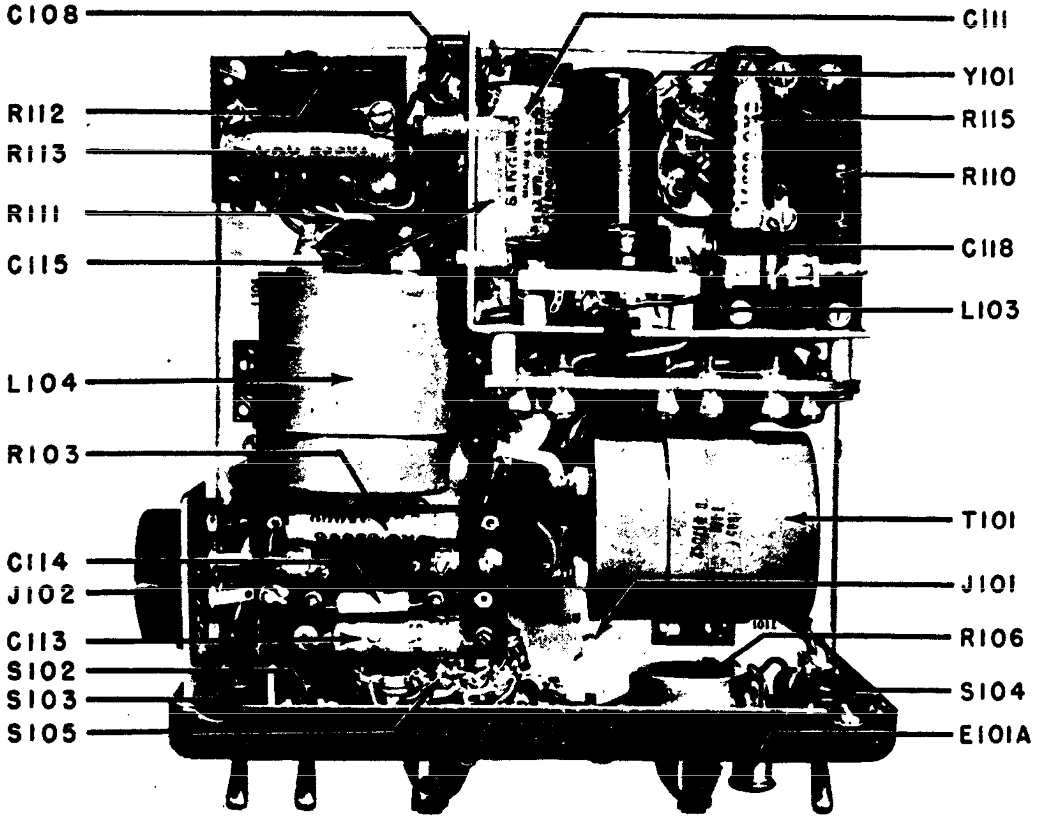


Figure 7–7. Heterodyne Frequency Meter — Location of Components, Bottom View of Chassis

(2) MECHANICAL ADJUSTMENTS.

(*a*) REMOVAL AND REPAIR.—Replacement of heterodyne oscillator components requires removal of the sub-chassis containing the band switch, coils, capacitors and other parts. To remove the assembly proceed as follows:

1. Remove the chassis from the housing. Loosen the tube clamps and remove all tubes, including voltage regulators V104 and V105.

2. Use an Allen-head wrench to loosen the set-screws and remove the CORRECTOR and FREQ. BAND knobs.

3. Remove the two screws which fasten the socket-shelf for V104 and V105 in place.

4. Insert a screw-driver through the holes on the flange at the rear of the main chassis and remove the two screws which fasten one section of the sub-chassis to the main chassis.

5. Remove the five screws which fasten the capacitor compartment shield in place and remove the shield.

6. Remove the seven screws at the right side, four screws at the left side, and three screws at the bottom of the main chassis, which fasten the sub-chassis in place. Remove only the fastening screws indicated. Note that the trimmer and corrector capacitors form part of the sub-chassis assembly.

7. Remove the four screws which fasten T101 in place, to provide access to the selector-link terminal board, TB103. Unsolder the six leads which form the cable emerging from the grommet at the left side (bottom view) of the chassis.

8. Unsolder the green lead from the capacitor compartment, at the junction with C106, on terminal board TB105, located behind V101. Unsolder the heavy, bare bus connection to the stator of tuning capacitor C101.

9. Slide the sub-chassis assembly towards the rear of the unit and unsolder the black ground lead from the frame of C101. Remove the sub-chassis.

10. Follow the above procedure in reverse, after replacement of components, to reassemble the heterodyne oscillator sub-chassis.

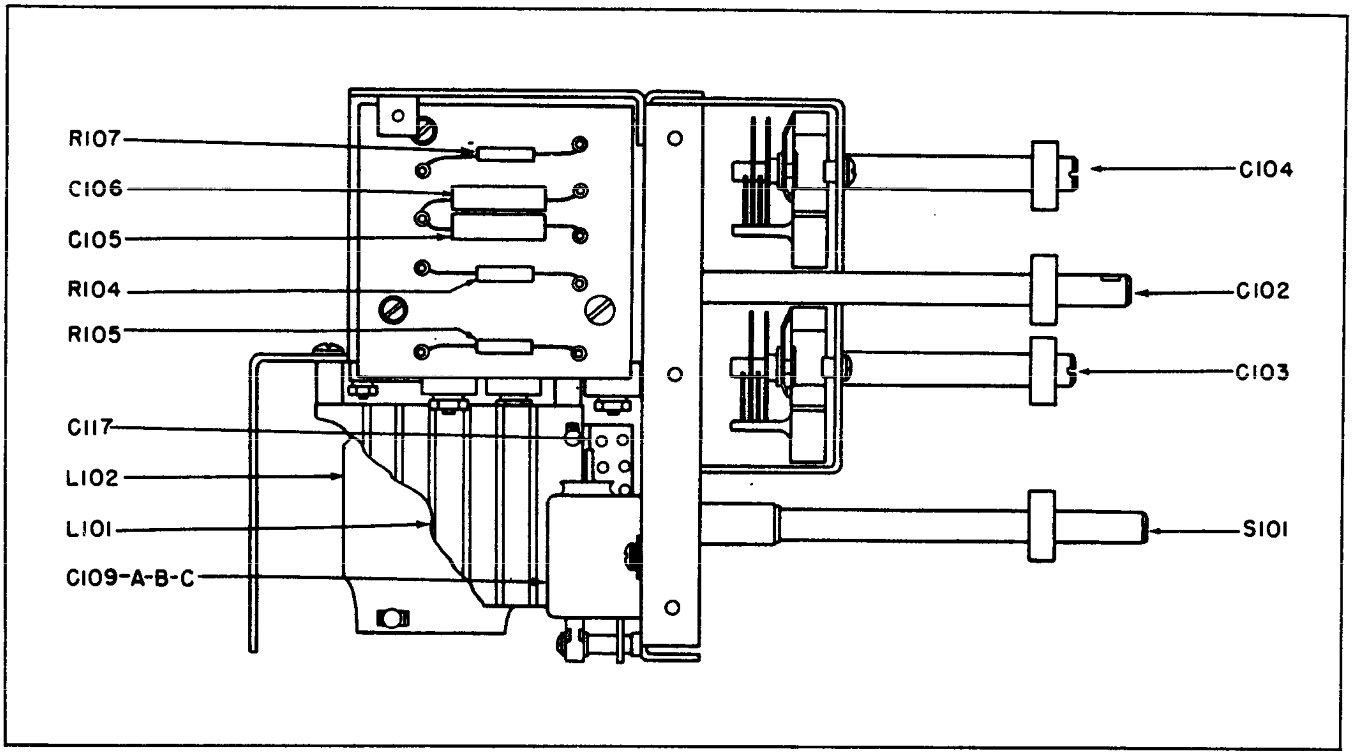


Figure 7–8. Heterodyne Frequency Meter – Location of Components, Left Side View of Heterodyne Oscillator Sub-Chassis

To replace the variable tuning capacitor, C101, proceed as follows:

1. Remove the heterodyne oscillator subchassis, as previously outlined.

2. Remove the tuning dial knob and DIAL UNITS plate, by removing the three fastening screws. Remove the outer dial ring.

3. Remove the three flat-head mounting screws which fasten the variable capacitor to the front panel. The uppermost screw is located behind the calibration scale at the top of the front panel. Carefully remove the capacitor.

4. Mount the replacement unit in place and stake or fix the mounting screws with insulating varnish.

5. Rotate the tuning shaft until the DIAL HUNDREDS window index is exactly aligned with the zero marking on the capacitor drum.

6. Slip the DIAL UNITS plate on the shaft, without fastening to the shaft. Center the dial ring about the plate and fasten loosely in place with the four mounting screws.

7. Position the DIAL UNITS plate to align the zero marking with the index arrow on the dial ring. Rotate the plate slightly about this position, if required, to align the mounting holes with those on the drive shaft. Fasten the plate and tuning knob in place.

8. Position the dial ring to make it concentric with the DIAL UNITS plate and tighten the mounting screws. The plate should rotate freely within the ring, without binding.

9. Replace the heterodyne oscillator subchassis, as previously indicated.

NOTE

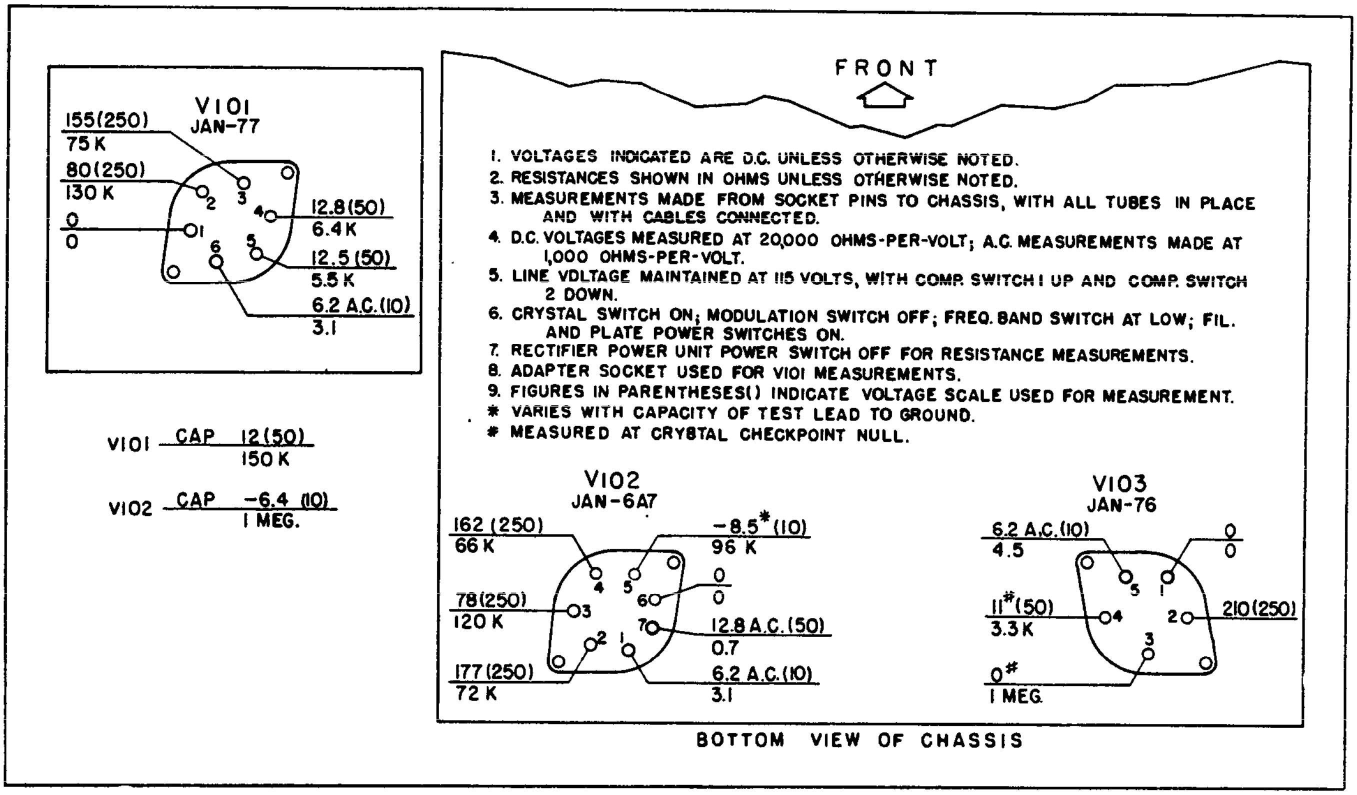
Replacement of the variable tuning capacitor necessitates recalibration of the Frequency Meter.

(3) COMPONENT CHARACTERISTICS.

(*a*) ELECTRON TUBES.—The operating voltages and currents of the tubes employed in the Frequency Meter are listed in table 7–6.

NOTE

ALL TUBES OF A GIVEN TYPE SUPPLIED WITH THE EQUIPMENT SHALL BE CONSUMED PRIOR TO EMPLOYMENT BY TUBES FROM GENERAL STOCK.



1. VOLTAGES INDICATED ARE D.C. UNLESS OTHERWISE NOTED.
2. RESISTANCES SHOWN IN OHMS UNLESS OTHERWISE NOTED.
3. MEASUREMENTS MADE FROM SOCKET PINS TO CHASSIS, WITH ALL TUBES IN PLACE AND WITH CABLES CONNECTED.
4. D.C. VOLTAGES MEASURED AT 20,000 OHMS-PER-VOLT; A.C. MEASUREMENTS MADE AT 1,000 OHMS-PER-VOLT.
5. LINE VOLTAGE MAINTAINED AT 115 VOLTS, WITH COMP. SWITCH 1 UP AND COMP. SWITCH 2 DOWN.
6. CRYSTAL SWITCH ON; MODULATION SWITCH OFF; FREQ. BAND SWITCH AT LOW; FIL. AND PLATE POWER SWITCHES ON.
7. RECTIFIER POWER UNIT POWER SWITCH OFF FOR RESISTANCE MEASUREMENTS.
8. ADAPTER SOCKET USED FOR V101 MEASUREMENTS.
9. FIGURES IN PARENTHESES() INDICATE VOLTAGE SCALE USED FOR MEASUREMENT.

* VARIES WITH CAPACITY OF TEST LEAD TO GROUND.

# MEASURED AT CRYSTAL CHECKPOINT NULL.

Figure 7–9. Heterodyne Frequency Meter — Voltage and Resistance Diagram, Tube Sockets

(*b*) CRYSTAL DATA.—The crystals used in the Type CBLC–74028 Heterodyne Frequency Meter are fabricated to prevent oscillation at any frequency other than the desired fundamental or harmonics of the fundamental, when operating at a temperature of 20 degrees Centigrade. The crystals provide a high degree of oscillation activity and freedom from spurious frequencies when installed in random selected Frequency Meters of the same group at all temperatures in the range from minus 32°C to plus 65°C. The crystal unit consists of a crystal assembly mounted in a metal tube envelope, hermetically sealed, and equipped with an octal base.

1. The acccuracy of the crystals is maintained within 0.001 percent (± ten cycles) of 1000 kc.

2. The temperature coefficient does not exceed 0.0001 percent (± ten cycles) per degree Centigrade, measured over a range of 80°C.

3. The accuracy of the crystals is maintained over the temperature range from minus 30°C to plus 50°C.

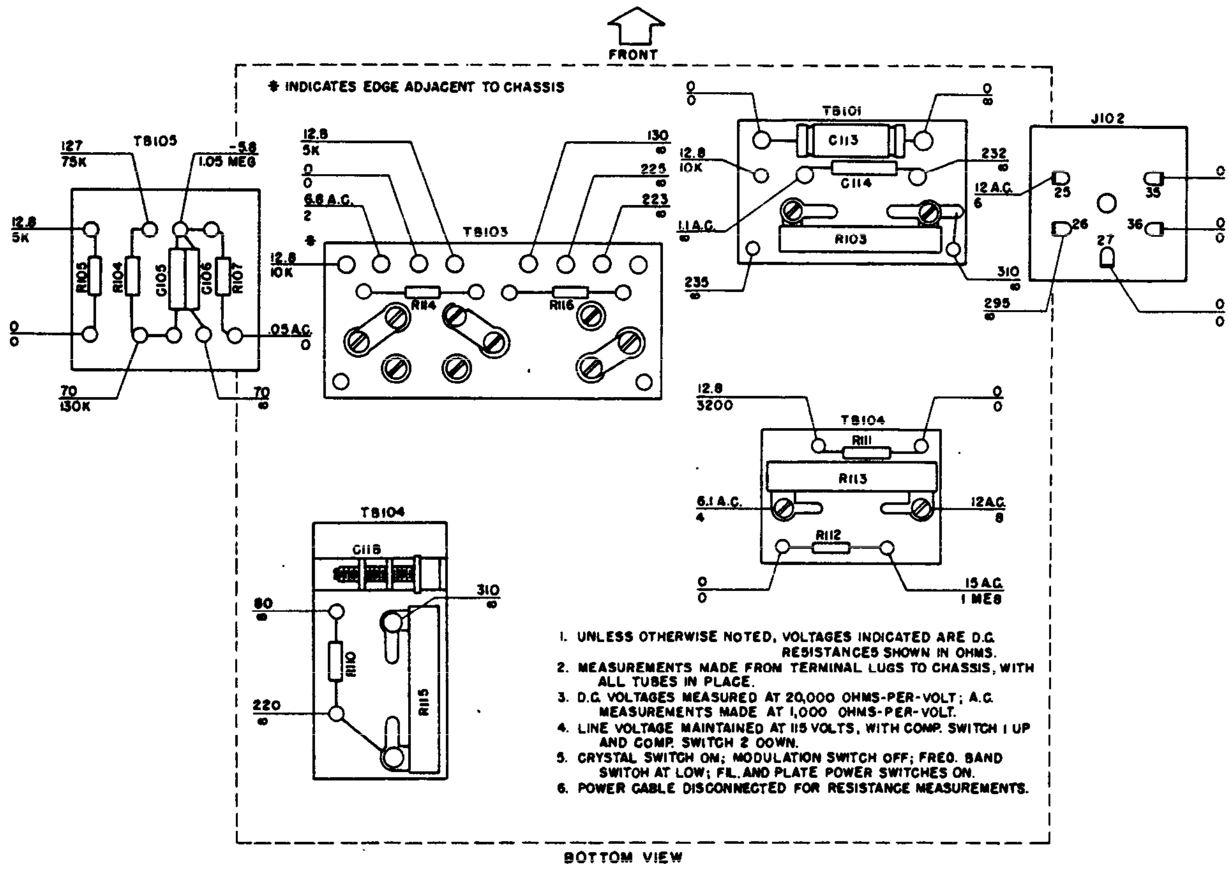
4. The input capacity of the crystal circuit is 15 mmf. The maximum unit capacitance of the crystal is 10 mmf.; the maximum equivalent resistance of the crystal is 1000 ohms.

5. The circuit of the crystal oscillator is shown in the schematic diagram of the Frequency Meter, figure 7–13.

6. The physical dimensions and electrical connections of the crystal holder are illustrated in figure 7–10.

7. The crystals are mounted in the holder so as not to vary more than 0.001 percent for prolonged vibration under simulated operation conditions, i.e., vibrations of 1/16-inch amplitude and with frequencies up to 3600 cycles per second; after violent shaking by hand; or after turning equipment in any position, i.e., upside down or on side, and returning to normal operating position.

8. The accuracy of the crystal will be maintained for variations in temperature, humidity, and voltage, and will normally exceed the stated values.



1. UNLESS OTHERWISE NOTED, VOLTAGES INDICATED ARE D.C. RESISTANCES SHOWN IN OHMS.
2. MEASUREMENTS MADE FROM TERMINAL LUGS TO CHASSIS, WITH ALL TUBES IN PLACE.
3. D.C. VOLTAGES MEASURED AT 20,000 OHMS-PER-VOLT; A.C. MEASUREMENTS MADE AT 1,000 OHMS-PER-VOLT.
4. LINE VOLTAGE MAINTAINED AT 115 VOLTS, WITH COMP. SWITCH 1 UP AND COMP. SWITCH 2 DOWN.
5. CRYSTAL SWITCH ON; MODULATION SWITCH OFF; FREQ. BAND SWITCH AT LOW; FIL. AND PLATE POWER SWITCHES ON.
6. POWER CABLE DISCONNECTED FOR RESISTANCE MEASUREMENTS.

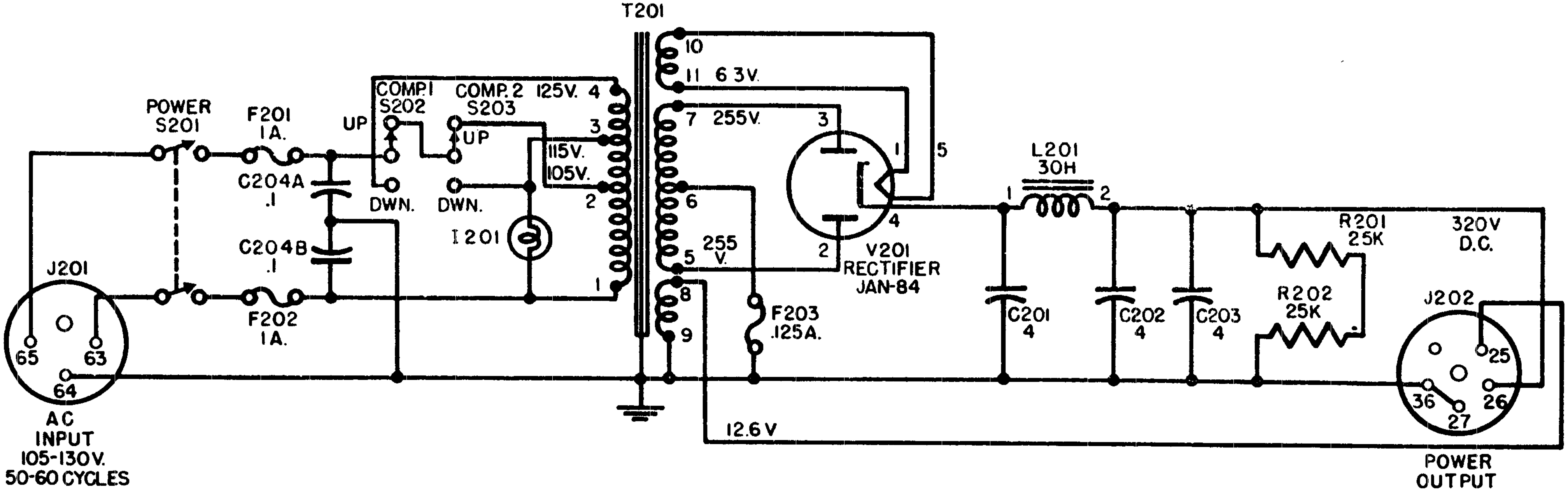
Figure 7–10. Heterodyne Frequency Meter — Voltage and Resistance Diagrams, Terminal Boards

TABLE 7–6. TUBE OPERATING VOLTAGES AND CURRENTS

TUBE TYPE	SYMBOL	FUNCTION	PLATE		SCREEN		SUPP. (E)	CATH. (E)	GRID (E)	HEATER (E)
			(E)	(MA)	(E)	(MA)				
JAN–77	V101	Heterodyne Osc.	80	0.9	155	1.6	12.8	0	- 12	6.2 A.C.
JAN–6A7	V102	Crystal Osc. Detector	177	0.9	78	2.4	—	0	- 6.4	6.2 A.C.
JAN–76	V103	Audio Amp. Modulator	210	3.7	—	—	—	11.5	0	6.2 A.C.
JAN–991	V104	Voltage Reg.	155	3.9	—	—	—	62.5	—	—
JAN–991	V105	Voltage Reg.	78	3.9	—	—	—	0	—	—
JAN–84	V201	Rectifier	260 A.C.	—	—	—	—	330	—	5.9 A.C.

NOTE:—D.c. measurements at 20,000 ohms-per-volt; a.c. measurements at 1000 ohms-per-volt. Input line voltage 115 volts, 60 cycles; COMP. switch 1 up, COMP. switch 2 down.

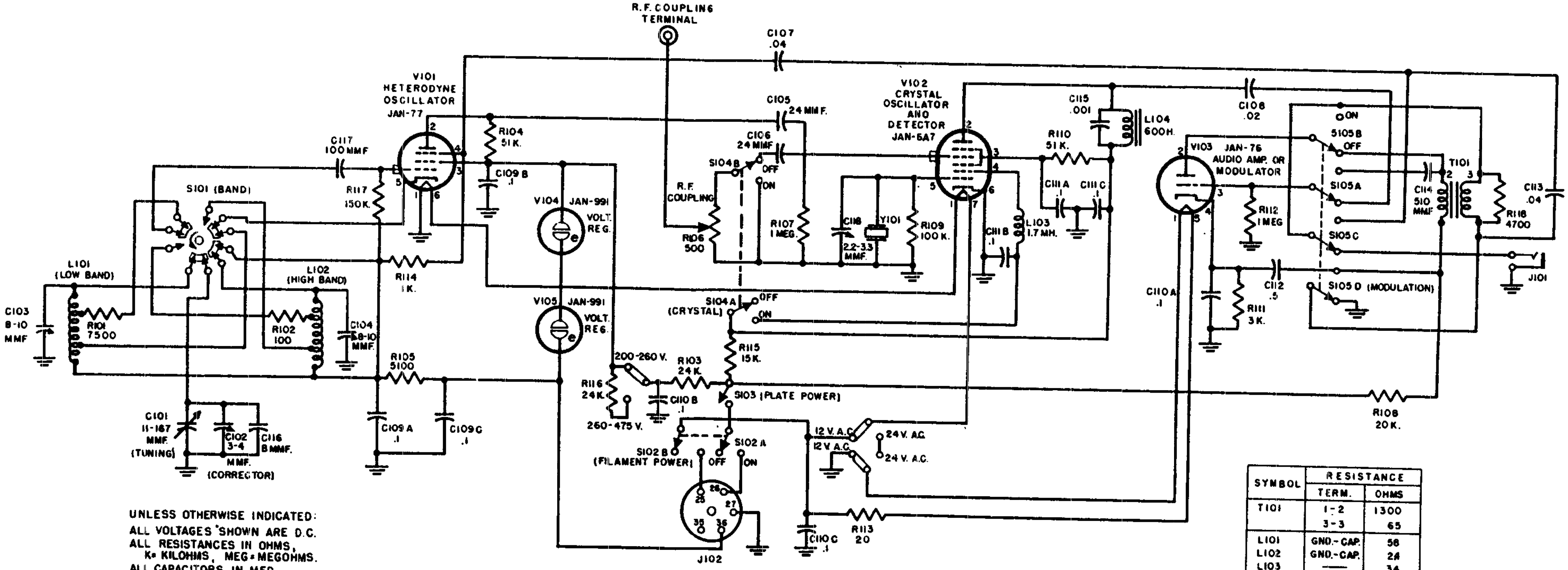
JAN–6A7: osc. grid = -8.5 volts; anode grid = 162 volts.



ALL VOLTAGES SHOWN ARE A.C.
ALL RESISTANCES IN OHMS,
ALL CAPACITORS IN MFD.,
UNLESS OTHERWISE INDICATED.
PIN VIEW OF RECEPTACLES J201 & J202 SHOWN.

SYMBOL	RESISTANCE	
	TERM.	OHMS
T201	1-2	10
	1-3	10.8
	1-4	11.6
	5-6	140
	5-7	280
	8-9	0.5
	10-11	0.5
L201	1-2	900

Figure 7–12. Type CBLC–20104A Rectifier Power Unit — Schematic Diagram



UNLESS OTHERWISE INDICATED:
ALL VOLTAGES SHOWN ARE D.C.
ALL RESISTANCES IN OHMS,
K= KILOHMS, MEG= MEGOHMS.
ALL CAPACITORS IN MFD.

PIN VIEW OF RECEPTACLE J102 SHOWN.

BANDSWITCH S101 SHOWN IN LOW BAND POSITION (REAR VIEW).

PLATE AND FILAMENT VOLTAGE LINKS LOCATED ON TB103.

SYMBOL	RESISTANCE	
	TERM.	OHMS
T101	1-2 3-3	1300 65
L101	GND.-CAP.	58
L102	GND.-CAP.	24
L103	——	34
L104	1-2	7000

Figure 7-13. Type CBLC-74028 Heterodyne Frequency Meter — Schematic Diagram